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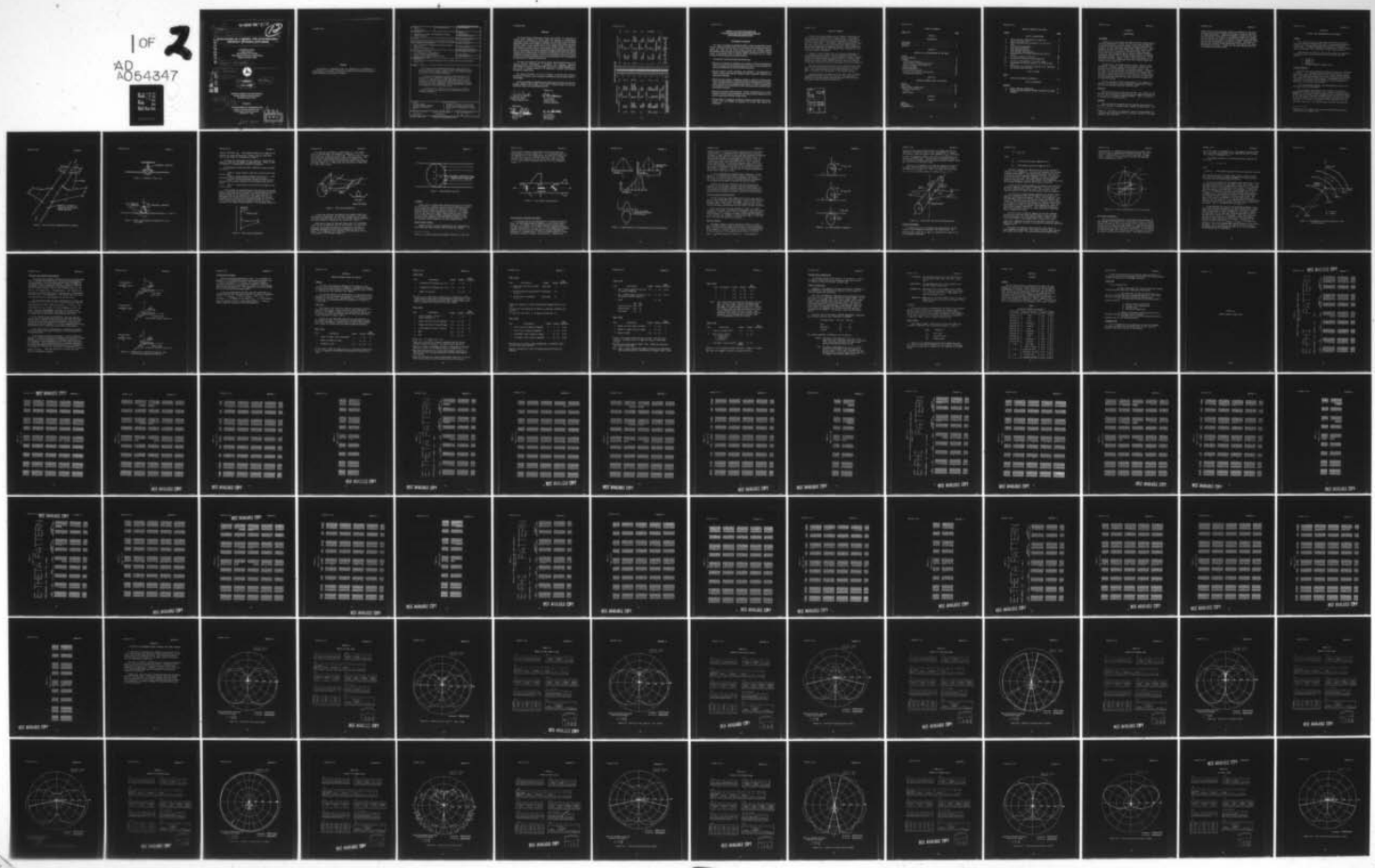

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EVALUATION OF A MODEL FOR SYNTHESIZING AIRCRAFT ANTENNA PATTERNS

IIT Research Institute
Under Contract to
DEPARTMENT OF DEFENSE
Electromagnetic Compatibility Analysis Center
Annapolis, Maryland 21402

F19628-78-C-0006

Alec Bulawka
Susan Stover

February 1976

FINAL REPORT.

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, DC 20590

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16. Abstract

The Federal Aviation Administration (FAA) tasked the Electromagnetic Compatibility Analysis Center (ECAC) to determine the impact of aircraft antenna radiation characteristics on Air Traffic Control Radar Beacon System (ATCRBS) performance.

An aircraft antenna pattern synthesis model developed by Ohio State University was examined in this report (Task 30, Part 1) to determine its applicability to ATCRBS performance analysis. Using the model as a vehicle, comparatively good patterns (with respect to measured data) were generated for several representative aircraft that employ the ATCRBS transponder. It was concluded that the model is well adapted to this type of application.

A subsequent report (Task 30, Part 2) discusses the effect of aircraft orientation, in conjunction with ATCRBS antenna patterns, on ATCRBS performance.

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PREFACE

The Electromagnetic Compatibility Analysis Center (ECAC) is a Department of Defense facility, established to provide advice and assistance on electromagnetic compatibility matters to the Secretary of Defense, the Joint Chiefs of Staff, the military departments and other DoD components. The Center, located at North Severn, Annapolis, Maryland 21402, is under executive control of the Assistant Secretary of Defense for Communication, Command, Control, and Intelligence and the Chairman, Joint Chiefs of Staff, or their designees, who jointly provide policy guidance, assign projects, and establish priorities. ECAC functions under the direction of the Secretary of the Air Force and the management and technical direction of the Center are provided by military and civil service personnel. The technical operations function is provided through an Air Force sponsored contract with the IIT Research Institute (IITRI).

This report was prepared for the Systems Research and Development Service of the Federal Aviation Administration in accordance with Interagency Agreement DOT-FA70WAI-175, as part of AF Project 649E under Contract F-19628-78-C-0006, by the staff of the IIT Research Institute at the Department of Defense Electromagnetic Compatibility Analysis Center.

The special contribution of Dr. W. D. Burnside of the Ohio State University Electroscience Laboratory, whose cooperation and assistance made this report possible, is acknowledged.

To the extent possible, all abbreviations and symbols used in this report are taken from American Standard Y10.19 (1967) "Units Used in Electrical Science and Electrical Engineering" issued by the USA Standards Institute.

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METRIC CONVERSION FACTORS

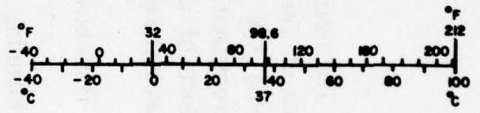
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 236, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



FEDERAL AVIATION ADMINISTRATION
SYSTEMS RESEARCH AND DEVELOPMENT SERVICE
SPECTRUM MANAGEMENT STAFF

STATEMENT OF MISSION

The mission of the Spectrum Management Staff is to assist the Department of State, Office of Telecommunications Policy, and the Federal Communications Commission in assuring the FAA's and the nation's aviation interests with sufficient protected electromagnetic telecommunications resources throughout the world to provide for the safe conduct of aeronautical flight by fostering effective and efficient use of a natural resource--the electromagnetic radio-frequency spectrum.

This objective is achieved through the following services:

- Planning and defending the acquisition and retention of sufficient radio-frequency spectrum to support the aeronautical interests of the nation, at home and abroad, and spectrum standardization for the world's aviation community.

- Providing research, analysis, engineering, and evaluation in the development of spectrum related policy, planning, standards, criteria, measurement equipment, and measurement techniques.

- Conducting electromagnetic compatibility analyses to determine intra/inter-system viability and design parameters, to assure certification of adequate spectrum to support system operational use and projected growth patterns, to defend the aeronautical services spectrum from encroachment by others, and to provide for the efficient use of the aeronautical spectrum.

- Developing automated frequency-selection computer programs/routines to provide frequency planning, frequency assignment, and spectrum analysis capabilities in the spectrum supporting the National Airspace System.

- Providing spectrum management consultation, assistance, and guidance to all aviation interests, users, and providers of equipment and services, both national and international.

EXECUTIVE SUMMARY

With the increasing density of air traffic, maintaining aircraft safety has become an item of prime concern. Continuous, uninterrupted surveillance of aircraft by ground controllers has become a virtual *must* in the heavily congested air environment over the United States. The Federal Aviation Administration (FAA) has kept stride with the ever-increasing surveillance needs by periodically upgrading its automated systems. These systems rely on the Air Traffic Control Radar Beacon System (ATCRBS) for accurate and reliable information.

Needing a better insight into air-to-ground transponder antenna coupling discontinuities, the FAA engaged the DoD ECAC to determine the suitability of antenna-pattern-synthesis computer programs for ATCRBS system performance analysis. The Ohio State University Antenna Pattern (OSUAP) synthesis model was selected as the more versatile of only two known models with this capability.

The model determines the effects of the basic aircraft structure on the radiation pattern of an antenna mounted on its fuselage. Four representative aircraft were selected to test the model's usefulness for application to FAA-related problems.

Antenna patterns were generated by the model for the ATCRBS transponder antennas on the four aircraft. The synthesized patterns closely approximate patterns obtained from scale-model measurements made by Lincoln Laboratories.

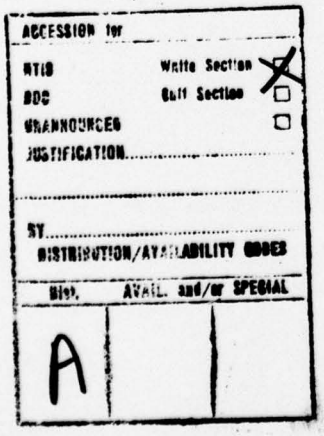


TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SECTION 1

INTRODUCTION

BACKGROUND

During the past few years the Federal Aviation Administration (FAA) has enhanced air traffic control surveillance through use of automated systems to provide target tracking, alpha-numeric displays, altitude reporting, and discrete identification. These automated systems rely on the ATCRBS (Air Traffic Control Radar Beacon System) for high-quality interference-free input data. The FAA and DoD have significantly improved ATCRBS performance through the AIMS (ATCRBS-IFF-MK XII System) Program, the ATCRBS Improvement Program, and the ATCRBS interrogator-control and PRF management programs. However, despite these improvements, problems relating to the ATCRBS omni-directional antenna aboard the aircraft still concern FAA.

Theoretically, the ATCRBS airborne antenna should be omni-directional. However, because of the antenna's location on the aircraft and shielding afforded by the wings, nacelles, and fuselage, nulls are generated in the antenna pattern. Frequently in a turn or a bank an aircraft antenna will be shielded from the direct line-of-sight path to an interrogator, thereby causing a broken or missed target return. This can result in track loss with the automated system and increased controller fatigue with the wide-band system.

The FAA, needing a better understanding of how ATCRBS performance is affected by aircraft antennas, engaged ECAC to determine aircraft antenna radiation characteristics.

OBJECTIVE

The objective of this task (Task 30, Part 1 of 2 parts) was to evaluate the suitability of antenna-synthesis computer programs for use in analyses of ATCRBS system performance. (Part 2 of Task 30 is covered in a separate report).[1]

APPROACH

ECAC obtained the documentation and computer program for the Ohio State University Antenna Pattern (OSUAP) synthesis model. The

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[1]Gibson, T., *Evaluation of Transponder Antenna Coverage/ATCRBS Performance During Simulated Flights of Aircraft*, FAA-RD-77-122, ECAC, Annapolis, MD, July 1976.

documentation and program were reviewed to determine if the model can be a useful tool in examining the impact of antenna patterns on ATCRBS performance. Factors considered in selecting this model were the ability of the model to accommodate movement of antennas on the fuselage; the variety of antenna types that can be modeled; the fact that the aircraft is treated as a three-dimensional shape; and the ease of modifying and using the program. The model was analyzed and executed on the ECAC UNIVAC 1110 computer for several representative aircraft. Comparisons were made between measured and computer-generated patterns.

SECTION 2

ANALYSIS AND IMPLEMENTATION OF THE MODEL

GENERAL

This section illustrates the application of the Ohio State University Antenna Pattern (OSUAP) model in determining radiation patterns for fuselage-mounted aircraft antennas in three principal planes. A detailed mathematical description of model development is presented by W. D. Burnside of Ohio State University.[2]

Four specific aircraft are used in this report for comparison between the model-synthesized patterns and measured patterns. They are:

1. BOEING 747
2. BOEING 727
3. CESSNA 150
4. MCDONNELL DOUGLAS PHANTOM (F-4H).

AIRCRAFT MODELING

The basic aircraft configuration analyzed herein is illustrated in Figure 1. It is composed of flat plates and a cylinder, which are the most important contributors to the antenna pattern development. The model was developed with certain limitations on defining the physical structure of the aircraft. The engines and vertical stabilizer were omitted from consideration and the fuselage was modeled as an infinitely long cylinder.

In the following paragraphs, the representations used by the Ohio State model are discussed.

The roll-plane cross section of an aircraft is in the X-Y plane which revolves around the Z axis. Figure 2 illustrates the BOEING 727, and Figure 3 shows the geometry of an idealized version of the same aircraft and the coordinate system as used in the model of the roll plane. Note that, for elliptical cross sections, the fuselage cross section is designated by both semi-major (a_f) and semi-minor (b_f) axes. For circular cross sections, one need only

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[2] Burnside, W. D., *Analysis of On-Aircraft Antenna Patterns,* Ohio State University, August 1972.

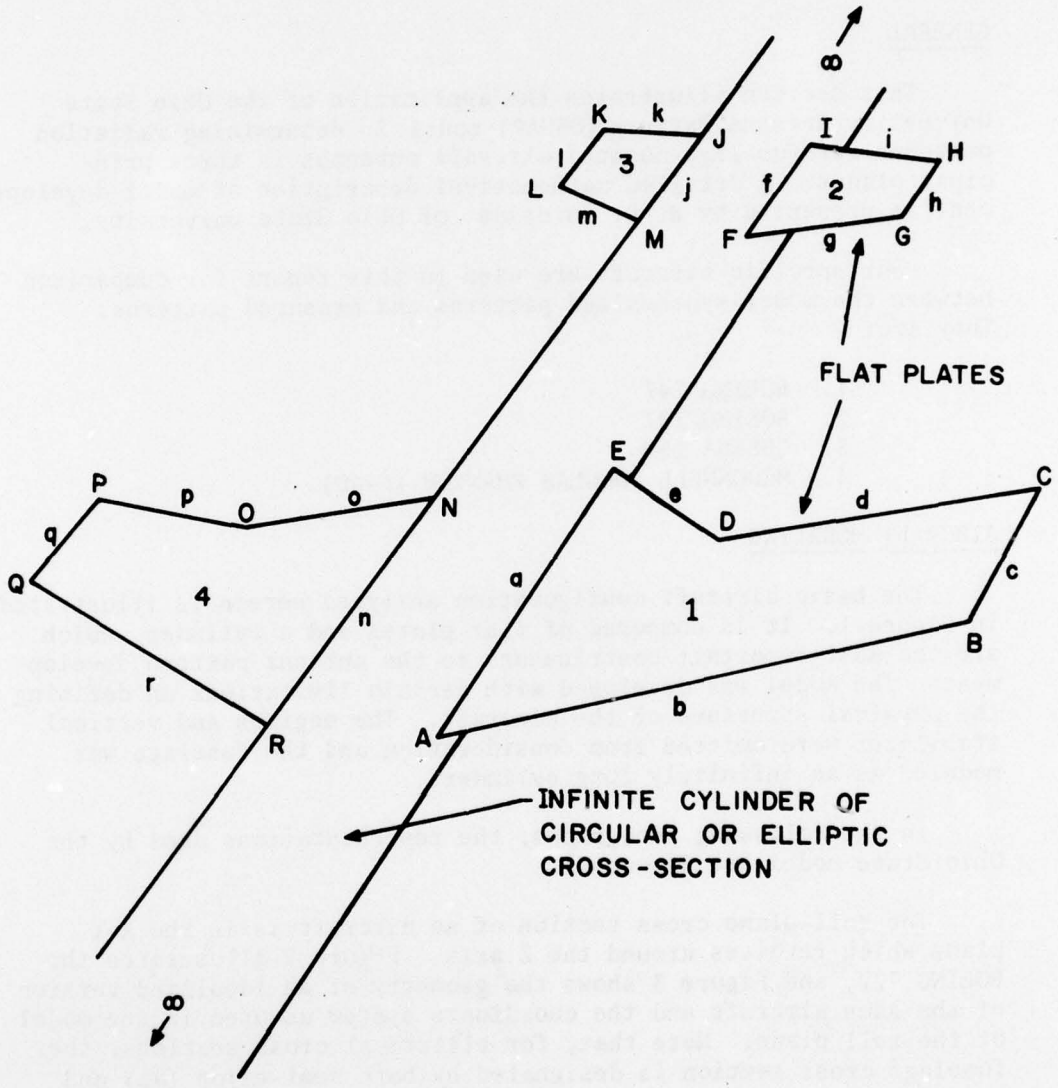

Figure 1. Basic aircraft configuration for analysis.

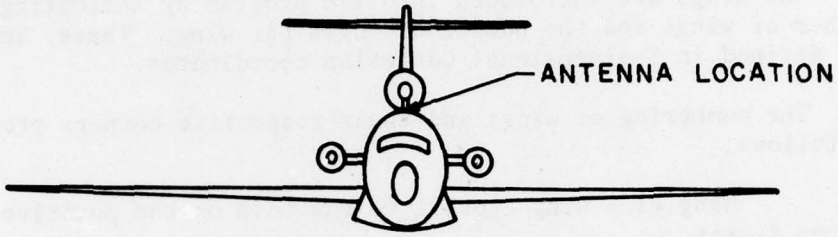

Figure 2. Boeing-727 front view.

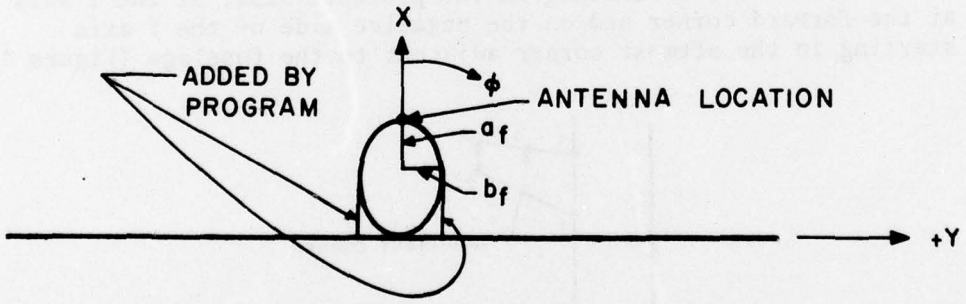

Figure 3. Model representation of Boeing-727 in the roll plane.

specify the radius (a_f). The program automatically completes the fuselage by extending tangential surfaces from the semi-minor axes to the wings, as illustrated in Figure 3.

The wings are introduced into the program by indicating the number of wings and the number of edges per wing. These, in turn are defined in 3-dimensional Cartesian coordinates.

The numbering of wings and their respective corners proceeds as follows:

Wing #1 - wing closest to the nose on the positive side of the Y-axis

Wing #2 - going counter-clockwise from wing #1 - is the horizontal stabilizer on the positive side of the Y axis

Wing #3 - continuing counter-clockwise around the tail and onto the horizontal stabilizer on the negative side of the Y axis

Wing #4 - wing closest to the nose on the negative side of the Y axis.

If the antenna is located forward in the vicinity of the main wings, it was found that the horizontal stabilizers may be omitted from the definition of the aircraft, since their contribution would be minimal in the generation of the overall pattern. As programmed, the corners of each wing are numbered in a counter-clockwise direction starting on the positive side, of the Y axis at the forward corner and on the negative side of the Y axis starting in the aftmost corner adjacent to the fuselage (Figure 4).

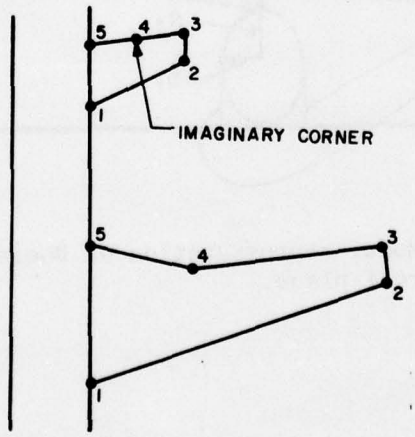

Figure 4. Wing corner designations.

The wing can be treated as a flat plate; i.e., all corners lying in the same plane (X-coordinate = constant), or it can have a bend (as in the case of the F-4H). The bent wing is entered as a flat plate, defining all the corners in the same plane. The axis of bend is then established by giving the numbers of the corners about which the wing is bent and the angle of bend between the wings (Figure 5). A flat plate (not bent) wing is identified by a 180° angle of bend.

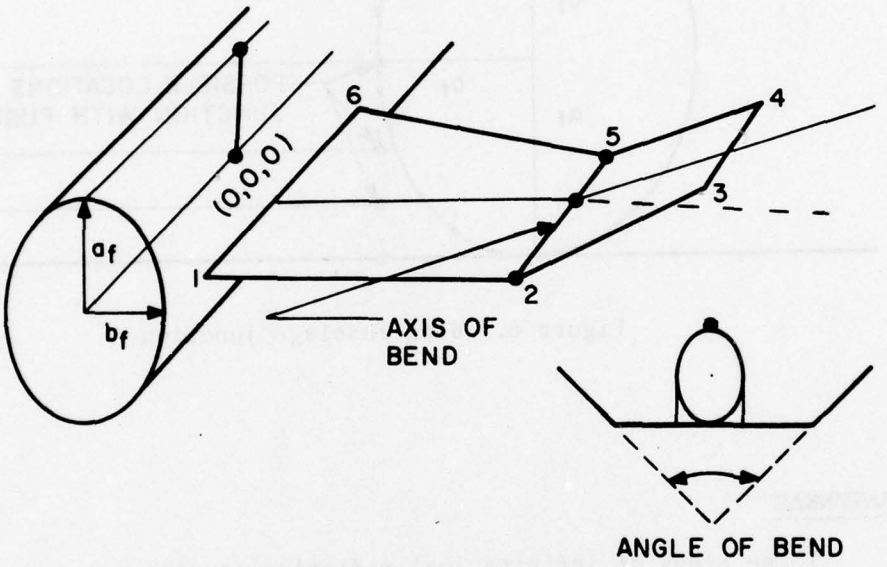

Figure 5. Bent-wing designations.

If more than two wings are modeled, the number of edges per wing should be consistent. If one pair of wings has five corners per wing and another pair has, say, four corners, then an imaginary 5th corner should be created for the second pair (Figure 4).

Wing corners along the fuselage should have the Y-coordinate values of the b_f semi-minor axis of the fuselage. As previously mentioned, the program automatically completes the fuselage by extending tangential surfaces from the semi-minor axes to the wings. The X-component can be anywhere within the limits of the a_f dimension of the fuselage (Figure 6).

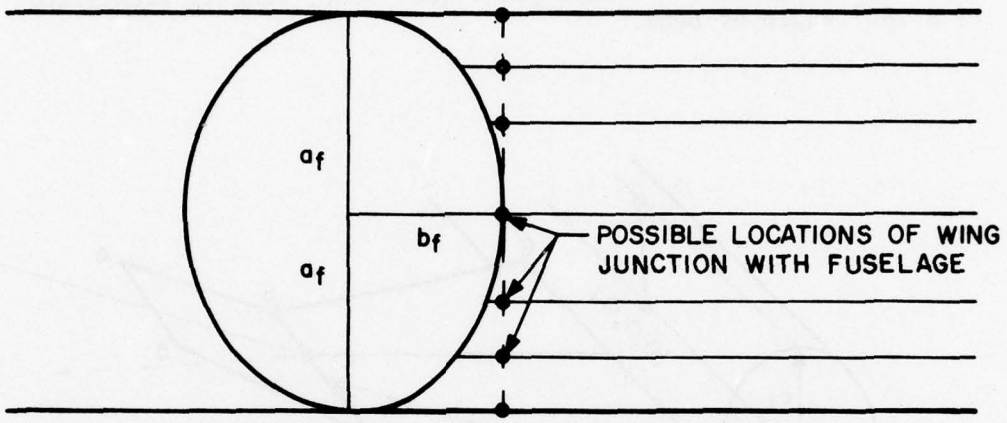

Figure 6. Wing-fuselage junction.

ANTENNAS

Three types of infinitesimal radiating sources are considered in this analysis: monopole, and axial and circumferential slots. The solutions allow for an arbitrary antenna to be considered, using a method of numerical aperture integration. Thus, many physical antennas can be approximated by any one, or a combination, of the three basic types. Small-diameter annular slots on the fuselage (used as ATCRBS transponder antennas in this analysis) have essentially the same radiation pattern as that of a monopole antenna mounted on an ideal ground plane.[3]

Infinitesimal Sources

Monopole and slot antenna configurations are represented by their amplitude (WM) and phase (WP) distributions (tapers). A

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[3]Jasik, H., *Antenna Engineering Handbook*, McGraw Hill, New York.

single-element antenna representation would have an amplitude distribution of one and a phase of 0°. A slot antenna (axial or circumferential) is also identified by the angle (β) between the slot and the Z axis in a clockwise direction. Thus, a circumferential slot would have β = 90° and an axial slot would have β = 0°. Other angular configurations for β are also acceptable (Figure 7).

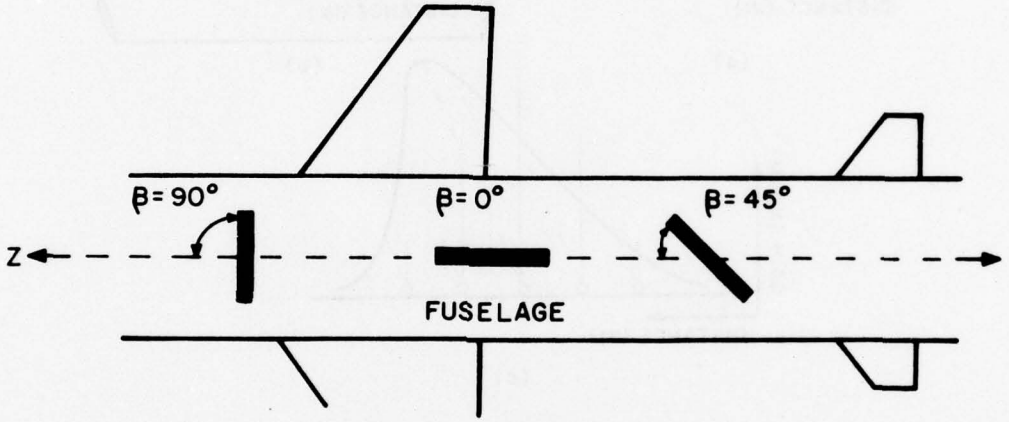

Figure 7. Slot antenna identification.

Varied Aperture Antennas and Arrays

Any antenna type can be represented by its aperture distribution. An open-ended waveguide antenna or a slot of any width in terms of λ, for example, can be approximated by stacking infinitesimal slots side-by-side to effect a desired aperture configuration and distribution. An array of up to six infinitesimal monopole elements can be utilized to represent an antenna configuration (analogous to a phased array). This can be done axially or circumferentially along the fuselage of the aircraft. Figure 8a, for

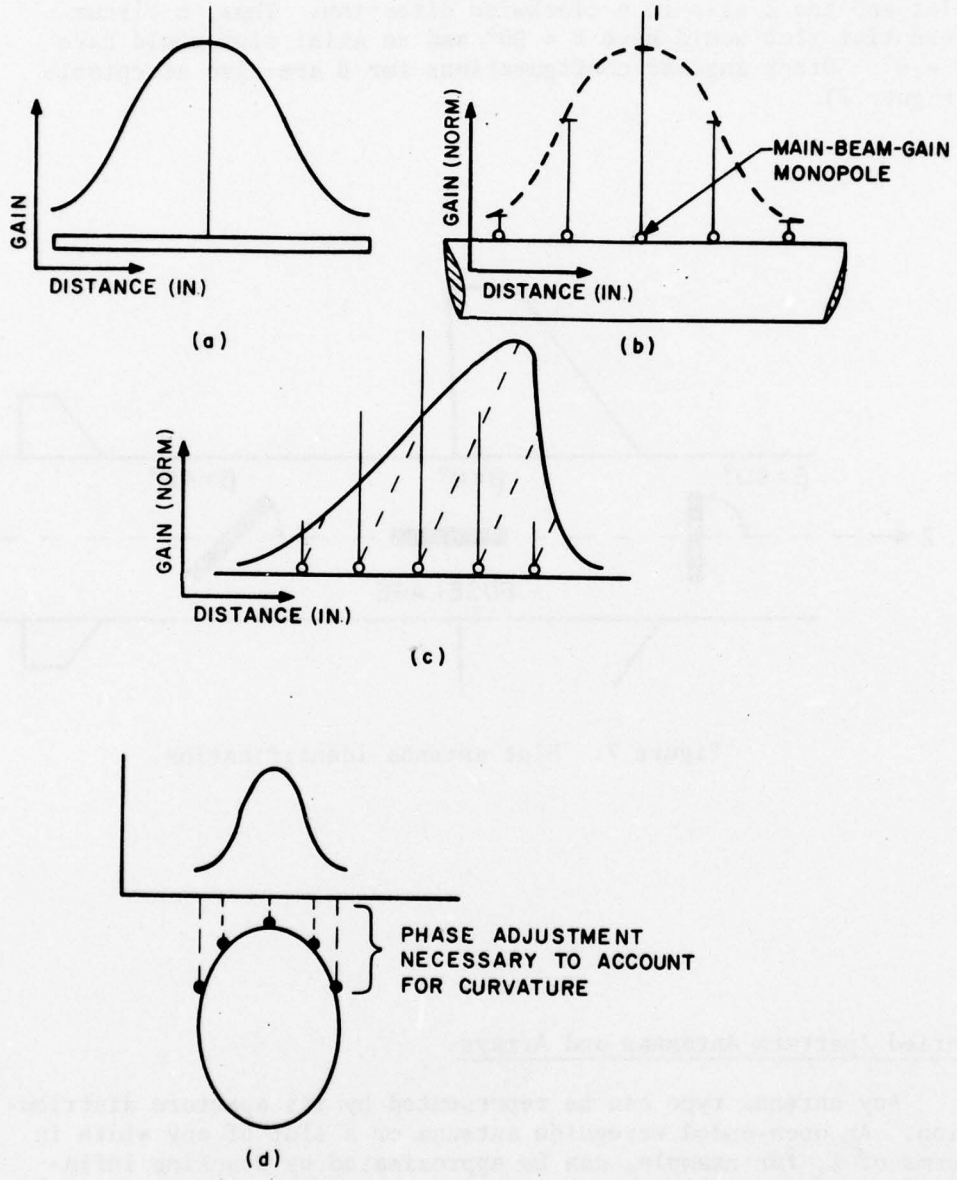

Figure 8. Representation of antenna aperture gain distribution.

example, shows an arbitrary aperture distribution for an antenna to be analyzed. A 5-monopole array arranged axially along the fuselage is scaled, giving the main beam gain monopole an amplitude distribution (WM) value of 1 and phase distribution (WP) of 0°. The remaining elements are then normalized in terms of WM. WP is equal to zero for all the elements since there is no phase shift between them, thus yielding a best-fit curve, Figure 8b, resembling Figure 8a. The main beam dominant monopole, as well as the other elements of the array, can be steered by the phase angle (WP) in any direction to give any desired distribution, as for example in Figure 8c. This is done by assigning appropriate values, other than zero, for WP.

In a circumferentially arranged array (Figure 8d), the WP values of all elements must also be scaled, in addition to the WM values, to effect the non-linear arrangement of elements. This array can also be steered by making additional adjustments to the amplitude and phase to produce the desired effect.

Antenna locations are restricted to the regions on the periphery of the fuselage. However, the model accommodates a wide variety of aircraft structures, and any single antenna can be represented accurately because of the logical relationships among aperture distribution, aircraft shape, and antenna pattern.

Antenna Frequency Considerations

Various scattering bodies should be no closer than approximately a wavelength away from the source, and the overall aircraft must be large in terms of the wavelength. This sets the lower frequency limit of the model. The upper frequency limit is dictated by the model representation of the actual aircraft considered.

Thus, for typical aircraft dimensions, there is no upper frequency restriction. The higher the frequency, the more accurate the pattern. Above 1 GHz ($\lambda \simeq 1$ ft.), accurate antenna patterns can be obtained. At frequencies where λ approaches the dimensions of the aircraft (for 100 MHz $\lambda \simeq 10$ feet, for 10 MHz $\lambda \simeq 100$ feet, etc.), the solutions become less accurate.

Antenna Location

The model assumes a totally reflecting (metallic) surface, and the antenna should be mounted within $\lambda/4$ of the fuselage surface. Location of the antenna can be anywhere along the periphery of the fuselage. In the X-Y plane its location is designated by the angle ϕ_{SO}, which is the angle from the +X-axis in the XY plane. ϕ_{SO} cannot exceed 90° (Figure 9). If the antenna is

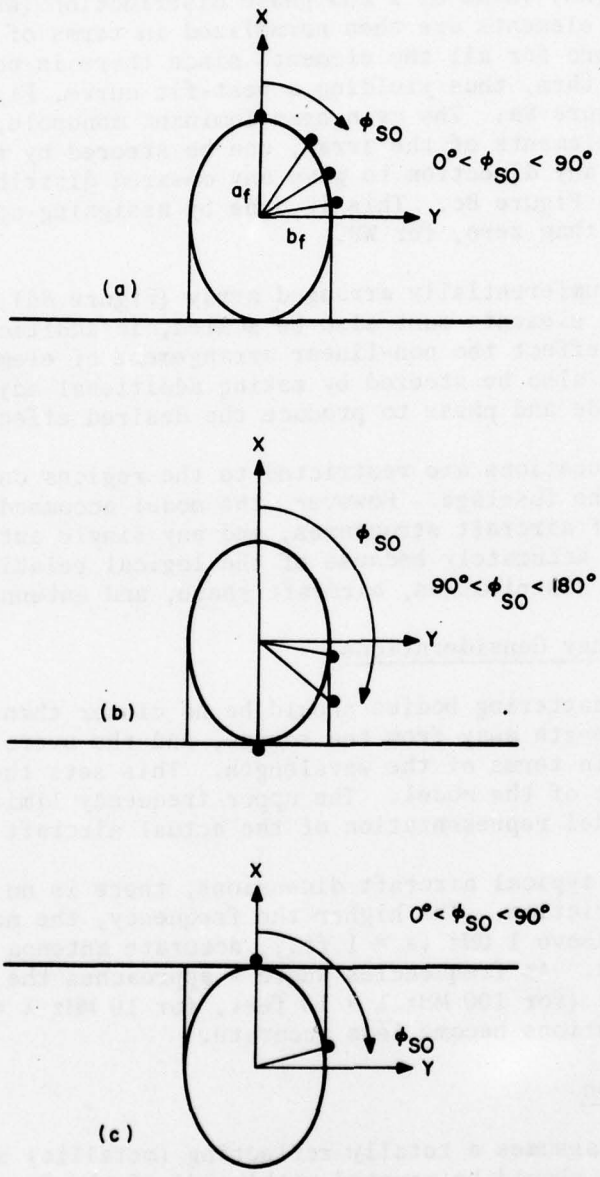

Figure 9. X-Y plane antenna orientation.

located on the belly of the aircraft as in Figure 9b, the aircraft must be rotated by 180° to the configuration of Figure 9c for analysis, where the angular limit imposed on ϕ_{SO} is satisfied. It must be remembered, however, that the resulting pattern will thus be reversed by 180°. Antenna location along the length of the fuselage is denoted by the Cartesian-coordinate distance along the Z axis from an arbitrary origin.

Usually it is convenient to locate the antenna such that it is always displaced from the origin of the coordinate system by the dimension a_f (Figure 10). Thus, the origin of the aircraft is at (0, 0, 0) and the antenna is located at (a_f, 0, 0).

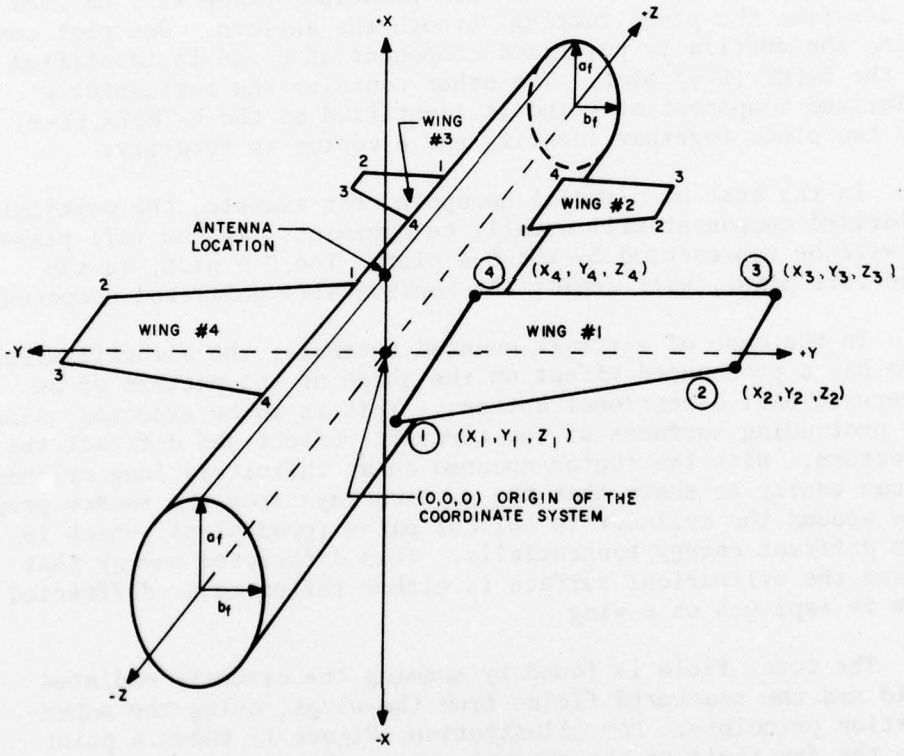

Figure 10. Antenna and flat-plate wing designations.

PATTERN DEVELOPMENT

An antenna pattern is a mathematical representation of the electric field strength surrounding a radiating source. The electric field vector ($\bar{E}$) in space is represented in terms of its two orthogonal components:

$$\overline{E} = \overline{E}_{\phi} + \overline{E}_{\theta}$$

where

$\overline{E}_{\phi}$ = vertically polarized component of $\overline{E}$

$\overline{E}_{\theta}$ = horizontally polarized component of $\overline{E}$.

The model computes the radiation pattern of the antenna in terms of its two components. Two plots are provided, one for each principal plane pattern. The term principal plane will be used to describe the plane cutting through the antenna. One plot contains the vertically polarized component of E and is identified as the E-PHI (E-ϕ) plot. The other contains the horizontally polarized component of E and is identified as the E-THETA (E-θ) plot. The two plots together identify the E vector in totality.

In the case of a radial monopole, for example, the vertically polarized component will usually be dominant. In the roll plane it will be represented by the E-ϕ plot. The E-θ plot, in the same roll plane, will depict the horizontally polarized component.

In the case of aircraft-mounted antennas, the aircraft structure has a pronounced effect on the shape of the pattern of an otherwise omni-directional antenna. This is to be expected, since the protruding surfaces of the aircraft reflect and diffract the E vectors. With the source mounted on an infinitely long cylinder, it can easily be shown that the surface rays from the source propagate around the cylinder in helical paths (geodesics), which in turn diffract energy tangentially. This diffracted energy that leaves the cylindrical surface is either reflected or diffracted when it impinges on a wing.

The total field is found by summing the directly radiated field and the scattered fields from the wings, using the superposition principle. For illustration, Figure 11 shows a point P in the far field of the antenna where a single total field vector ($\overline{E}$) is depicted in terms of its vertically polarized (perpendicular) component (E-ϕ) and its horizontally polarized (parallel) component (E-θ).

The model will generate antenna patterns with respect to three different orientations: roll plane, elevation plane (pitch), and azimuth plane (yaw). The elevation plane and azimuth plane

configurations are obtained by shifting the roll plane orthogonally so that, in generating the antenna patterns, the aircraft is rotated about its roll, pitch or yaw axis, as appropriate. Therefore, the roll plane is used as the reference plane throughout this report.

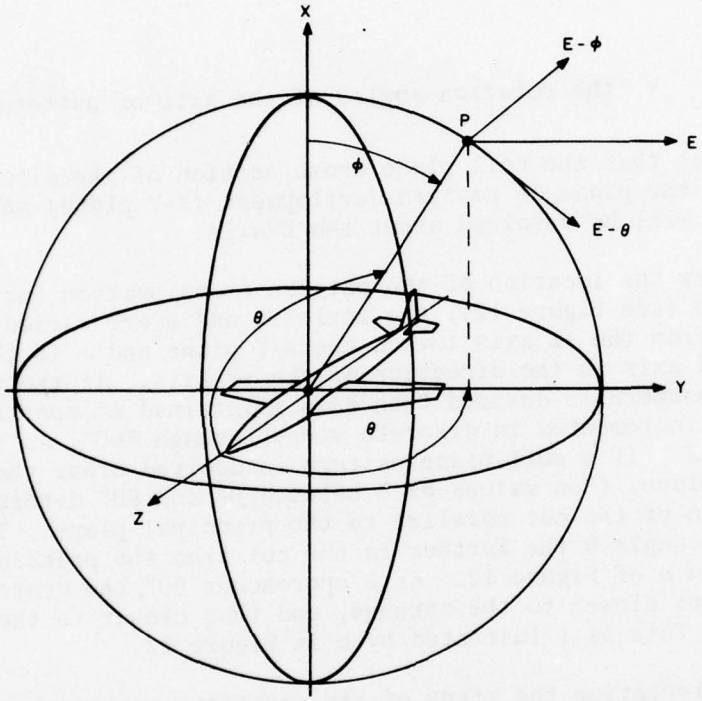

Figure 11. E-vector representation in the roll plane.

Roll-Plane Orientation

The roll-plane orientation is established by designating the axis through the fuselage as the Z axis (nose to tail). The axis through the wings is the Y axis and the X axis is mutually perpendicular to the Y and Z axis (see Figure 11). With this convention established, the antenna pattern will be developed by rotating the aircraft about the Z axis (the axis of rotation). As the aircraft is revolved through 360°, the pattern will be traced in the principal plane (in this case the roll plane). The angular excursion

in the X-Y plane is designated as ϕ. The angular excursion from the Z axis (axis of rotation) in the direction of the X-Y plane (roll plane) is designated as θ.

For program execution, the following criteria identify the roll plane:

$$\theta_c = 0°, \phi_c = 0°$$

where

θ_c and ϕ_c = the rotation angles of the axis of pattern rotation.

This implies that the roll plane cross section of the aircraft will be in the plane of pattern development (X-Y plane) and that this plane will be revolved about the Z-axis.

To vary the location of the pattern cross section for a given orientation (see Figure 12), the angles θ and ϕ are varied. θ is the angle from the +Z axis toward the X-Y plane and ϕ is the angle from the +X axis in the direction of the +Y axis. If the principal-plane pattern is desired then θ is maintained at constant 90° while ϕ is incremented in discrete steps through 360°, as in *a* of Figure 12. If a roll-plane pattern is desired other than the principal plane, then values of θ between 0° and 90° determine the location of the cut parallel to the principal plane. The smaller the angle θ the further is the cut from the principal plane, as in *e* of Figure 12. As θ approaches 90°, the cross section location gets closer to the antenna, and thus closer to the principal plane. This is illustrated by *b* in Figure 12.

In implementing the steps of the preceding paragraph to generate these laminate cuts parallel to the principal plane, certain contraints on ϕ and θ should be understood. The angle ϕ always cycles through 360° in equal increments of one degree or greater. The smoothest plot one can expect from the model would contain 360 data points spaced at 1° increments. Thus, the accuracy of the plot can be controlled by specifying the desired angular separation between successive calculations. The angle θ, if allowed to remain constant ($\theta_{initial} = \theta_{final}$), will generate a laminate of the solid 3-dimensional pattern parallel to the principal plane. If θ is allowed to vary from 0° to 180°, in equal increments while ϕ goes through its 360° cycle, a solid 3-dimensional pattern may be constructed.

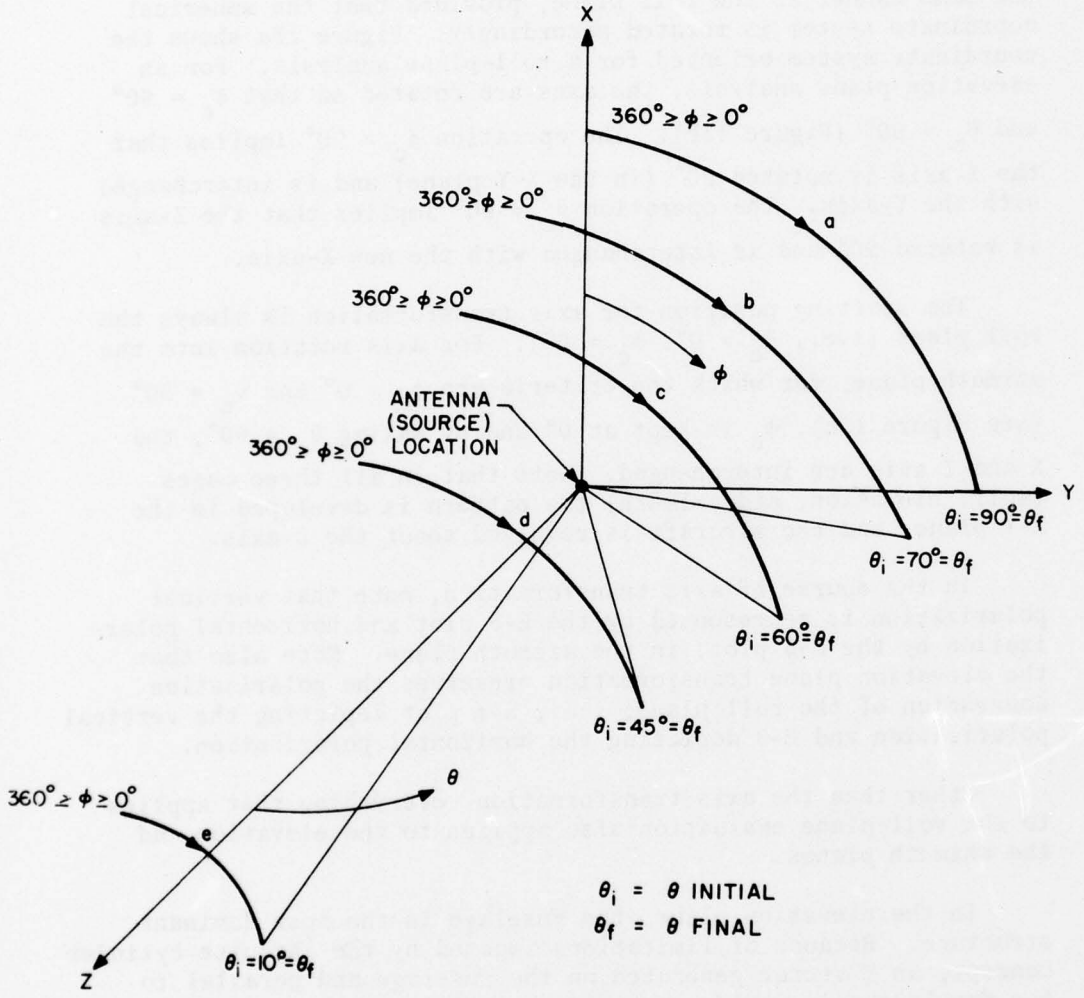

Figure 12. Development of patterns parallel to the principal plane.

Elevation and Azimuth Plane Analyses

The program was originally written to do the roll-plane analysis. Elevation and azimuth plane analyses are accomplished in the same manner as the roll plane, provided that the spherical coordinate system is rotated accordingly. Figure 13a shows the coordinate system oriented for a roll-plane analysis. For an elevation plane analysis, the axes are rotated so that $\phi_c = 90°$ and $\theta_c = 90°$ (Figure 13b). The operation $\phi_c = 90°$ implies that the X-axis is rotated 90° (in the X-Y plane) and is interchanged with the Y-axis. The operation $\theta_c = 90°$ implies that the Z-axis is rotated 90° and is interchanged with the new X-axis.

The starting position for axis transformation is always the roll plane (i.e., $\theta_c = 0°$, $\phi_c = 0°$). For axis rotation into the azimuth plane, for which the criteria are $\phi_c = 0°$ and $\theta_c = 90°$ (see Figure 13c), ϕ_c is kept at 0° and by making $\theta_c = 90°$, the X and Z axis are interchanged. Note that in all three cases (roll, elevation, and azimuth) the pattern is developed in the X-Y plane, and the aircraft is revolved about the Z-axis.

In the course of axis transformation, note that vertical polarization is represented by the E-θ plot and horizontal polarization by the E-ϕ plot, in the azimuth plane. Note also that the elevation plane transformation preserves the polarization convention of the roll plane; i.e., E-ϕ plot depicting the vertical polarization and E-θ depicting the horizontal polarization.

Other than the axis transformation, everything that applies to the roll-plane evaluation also applies to the elevation and the azimuth planes.

In the elevation plane, the fuselage is the most dominant structure. Because of limitations imposed by the infinite cylinder concept, an E vector generated on the fuselage and parallel to the fuselage axis would propagate to infinity without reflecting or diffracting. This causes difficulties in program execution. In running the program in the elevation plane, it is recommended that angles 90°, 90° and 270° be avoided in implementing $\theta_{initial}$, θ_{final}, and θ_{inc}. Replacing them by 89°, 89° and 269° will result in successful execution.

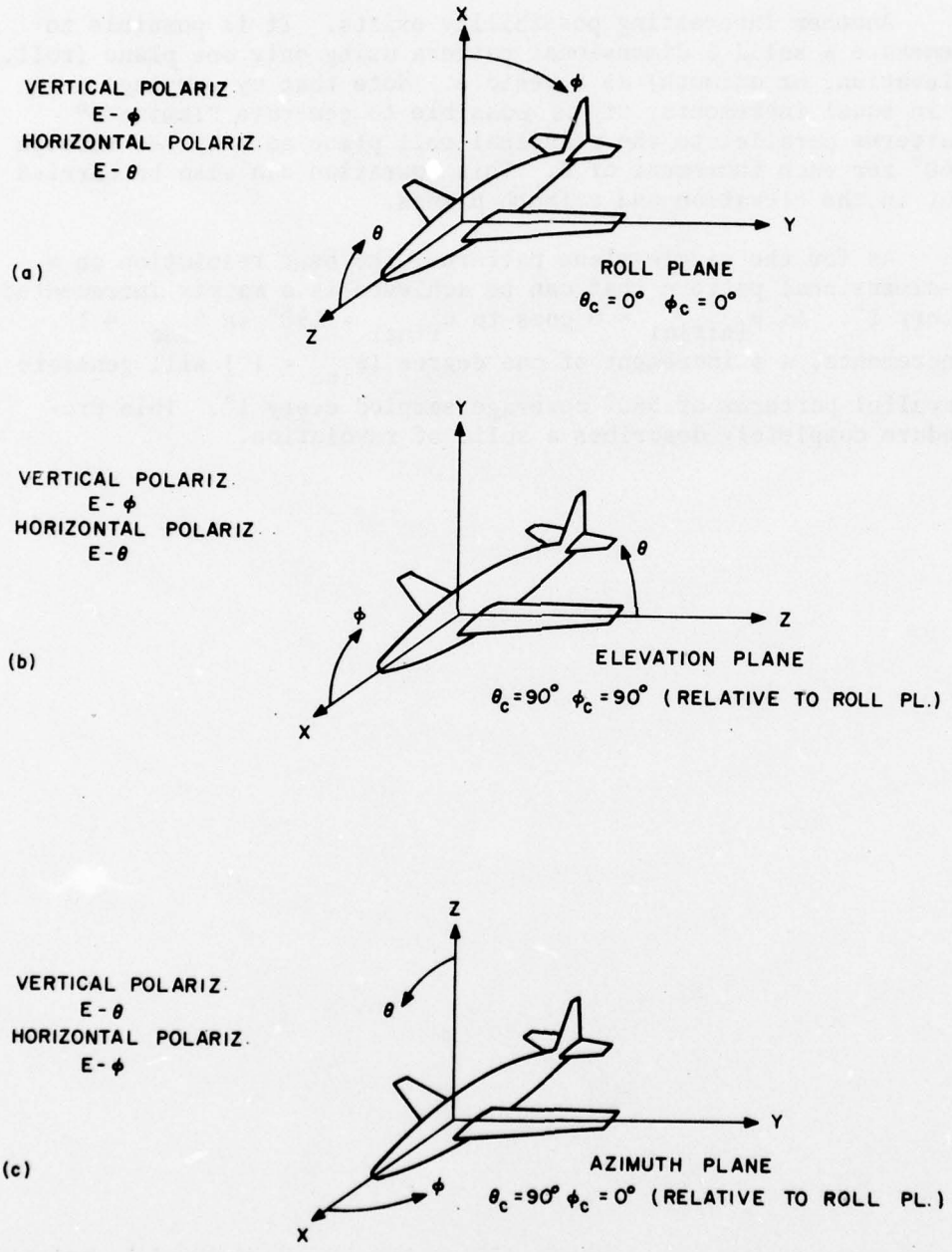

Figure 13. Orientation of coordinate system for roll, elevation, and azimuth plane analyses.

3-Dimensional Patterns

Another interesting possibility exists. It is possible to generate a solid 3-dimensional pattern using only one plane (roll, elevation, or azimuth) as a vehicle. Note that by varying θ in equal increments, it is possible to generate "laminate" patterns parallel to the principal roll plane as ϕ cycles through 360° for each increment of θ. This operation can also be carried out in the elevation and azimuth planes.

As for the single-plane patterns, the best resolution on a 3-dimensional pattern that can be achieved is a matrix incremented every 1°. As $\theta_{initial} = 0$ goes to $\theta_{final} = 180°$ in $\theta_{inc} = 1°$ increments, a ϕ increment of one degree ($\phi_{inc} = 1°$) will generate parallel patterns of 360° coverage sampled every 1°. This procedure completely describes a solid of revolution.

SECTION 3

COMPUTER PROGRAM INPUTS AND OUTPUTS

GENERAL

The Ohio State University Antenna Pattern model has been compiled on the ECAC UNIVAC 1110 computer. Information is entered on standard 80-column automatic data processing cards whose formats are described in this section of this report.

The program output is in tabular form on a high-speed printer, and data may also be produced on a magnetic tape for use on a programmable X-Y plotter (e.g., CALCOMP plotter). If the tape option is selected, the antenna patterns are automatically plotted in a polar form.

INPUT DATA

Nine types of data cards are required for program execution; under some conditions, several cards of a single type may be required. For example, as many as six cards (type 3) may be used to describe an array type antenna; and the wing description may require multiples of types 7 and 8.

Formats for the input data cards follow, and references to the appropriate pages in this report are included where necessary for further explanation. Control cards are not included because their format is a function of the type of computer available.

Type 1 Card

Item	Description	Format	Columns	Page Reference
1	Number of wings to be considered[a]	I	1 - 10	6
2	Number of edges per wing	I	11 - 20	6
3	Frequency in GHz	F.P.	21 - 30	11

[a] If more than 2 wings are being used (e.g., horizontal stabilizers), the no. of edges per wing should be consistent for both sets of wings.

Type 2 Card

Item	Description	Format	Columns	Page Reference
1	X-dimension of fuselage (a_f) (in.)	F.P.	1 - 10	7
2	Y-dimension of fuselage (b_f) (in.)	F.P.	11 - 20	7
3	Number of sources[a]	I	21 - 30	9

[a]An array can be constructed, consisting of a maximum of 6 infinitesimal elements, depicting any desired aperture distribution. Each element of the array must be entered with a separate Type 3 card. Thus a 6-element array would have six type 3 cards.

Type 3 Card

Item	Description	Format	Columns	Page Reference
1	Type of antenna, if slot = 1 Radial monopole = 2	I	1 - 10	8
2	Angle slot with Z axis[a] (degrees)	F.P.	11 - 20	9
3	Angular position of source[b] (deg)	F.P.	21 - 30	11
4	Z-coordinate of source[c] (inches)	F.P.	31 - 40	13
5	WM[d]	F.P.	41 - 50	9
6	WP[e]	F.P.	51 - 60	9

[a]Axial slot = 0°, Radial slot = 90°.

[b]Angle not to exceed 90°. If angle is greater than 90° (source located on belly of aircraft), see discussion in Section 2.

[c]Generally origin of coordinate system is established on the fuselage axis (z axis) at the antenna source, in which case Z = 0.

[d]Amplitude distribution; for single infinitesimal source WM = 1; for an array, can be scaled according to aperture distribution (see page 10).

[e]Phase distribution; for single infinitesimal source WP = 0; for an array can be scaled to steer the main beam (see discussion).

Type 4 Card

Item	Description	Format	Columns	Page Reference
1	Additional write out desired[a] (T or F)	Field Data	5	--
2	Pattern plotted by pen plotter[b] (T or F)	Field Data	10	--
3	Is flat plate considered[c] (T or F)	Field Data	15	7

[a]Dump; for purposes of trouble shooting when program does not compute.

[b]If pictorial representation of pattern is desired; interface with plotter.

[c]If wings are flat then = T, if wings are bent then = F.

Type 5 Card

Item	Description	Format	Columns	Page Reference
1	Initial value of theta in degrees[a]	I	1 - 5	15-20
2	Final value of theta in degrees[a]	I	6 - 10	15-20
3	Incremental step in theta in degs.[b]	I	11 - 15	15-20
4	Incremental step in phi in degrees[b]	I	16 - 20	15-20

[a]Constraints on θ, while ϕ goes through 360°, to generate conics and principal plane patterns.

[b]Angular increments in θ and ϕ at which values of $\bar{E}$ field are desired.

Type 6 Card

Item	Description	Format	Columns	Page Reference
1	THC - rotation angle of the axis of rotation (degrees)	F.P.	1 - 10	15-20
2	PHC - rotation angle of the axis of pattern rotation (degrees)	F.P.	11 - 20	15-20
3	Blank		21 - 30	

	THC	PHC
Elevation plane =	90°	- 90°
Azimuth plane =	90°	- 0°
Roll plane =	0°	- 0°

Type 7 Card

Item	Description	Format	Columns	Page Reference
1	Number of first corner at bend[a]	I	1 - 10	7
2	Number of second corner at bend[a]	I	11 - 20	7
3	Angle of bend[b]	F.P.	21 - 30	7

[a]Corners of wing that define the axis of bend. For flat plate wing (i.e. no bend) use no. of edges per wing for both items on card.

[b]For flat plate wing angle of bend = 180°. Should be consistent with item 3, type 4 card.

Note: Card 1, item 1 defines the number of wings to be considered. Each wing definition is introduced by a separate type 7 card.

Type 8 Card

Item	Description	Format	Columns	Page Reference
1	X	F.P.	1 - 10	6-7
2	Y	F.P.	11 - 20	6-7
3	Z	F.P.	21 - 30	6-7

Note: This card defines the Cartesian coordinates of each wing. Item 2 on Card 1 defined the number edges per wing. This number should be consistent with the number of type 8 cards per wing, i.e., if there are 4 corners per wing then there should be 4 type 8 cards defining each corner of the wing. Each additional wing (taken in proper counter-clockwise sequence) will be preceded by a new Type 7 and by a corresponding set of type 8 cards.

Type 9 Card

Item	Description	Format	Columns	Page Reference
1	Inches of desired plot[a]	F.P.	1 - 10	--
2	Type of plot (IPLOT) 1 = field plot 2 = power plot 3 = dB plot	I	11 - 12	--
3	Field data - Title of plot[b]	Alpha-numeric	13 - 55	--

[a]Depends on size of paper available for plot. Common is 4 inches.

[b]May input any comment necessary to identify the plot.

PROGRAM OUTPUT DESCRIPTION

The antenna pattern model output is in two forms: a series of computer-printed tables, and a magnetic tape for use on an X-Y plotter to draw the patterns in polar form.

Computer Tabulations

Examples of the computer listings are provided in APPENDIX A. The coordinate system presented in Figure 11 can be used as a reference during this discussion.

Note that two APPENDIX A tabulations are associated with each pattern, the first captioned E-PHI and the second E-THETA. In the roll plane, for example, the E-PHI vector is that E-field vector normal to the principal plane, while the E-THETA vector is the E-field vector parallel to the principal plane. For antennas whose polarization is perpendicular to the principal plane, the E-PHI vector will dominate over most of the pattern. When the polarization is orthogonal, the E-THETA vector will dominate over most of the pattern. The reverse is true for the azimuth plane.

The first line of the output, ROTATED COORDINATES, identifies the principal plane as roll, elevation, or azimuth:

Principal Plane	THC (θ_c)	PHC (ϕ_c)
Roll	0	0
Elevation	90	90
Azimuth	90	0

The columnar headings in APPENDIX A are as follows:

THETA: The angle θ (see Figures 11, 12, 13). θ is always 90° when a principal plane plot is desired; other values may be chosen or it may be automatically incremented (Data Card 5).

PHI: The angle ϕ (see Figures 11, 12, 13). ϕ will usually be incremented in discrete angles of not less than 1°, 0° to 360°, in which case the antenna pattern entirely around the aircraft will be computed and tabulated (Data Card 5).

E-PHI/PHASE: The magnitude and phase of the E-PHI vector at the designated angle (PHI) (on E-PHI listing only).

E-THETA/PHASE: The magnitude and phase of the E-THETA vector (on the E-THETA listing only).

UNNORMALIZED: Magnitude of the E-PHI/E-THETA vector (IPLOT = 1), in terms of the square of that value (IPLOT = 2), or in dB (IPLOT = 3). IPLOT values are specified on Type 9 cards.

NORMALIZED: Magnitude of the E-PHI/E-THETA vector in numerical terms and decibels relative to the largest value of the vector.

X-Y Plot

If the plot option was requested at the outset of the program (CARD 4) then the data will be formatted on a plotter tape. The plots consist of one polar coordinate grid for E-THETA and one for E-PHI. The size of the plot is governed by the dimensions of the paper available at the plotter utilized and is specified at input by: RADC = *size in inches* of desired plot.

Sample Output

Three sample computer tabulations of E-PHI and E-THETA are included in APPENDIX A for illustrative purposes. They are:

Table	BOEING 747
A-1	Roll Plane
A-2	Elevation Plane
A-3	Azimuth Plane

Samples of the CALCOMP polar plots and accompanying input data cards are provided in APPENDIX B to this report, where measured patterns from Lincoln Laboratories are compared to the OSUAP output.

SECTION 4

RESULTS

GENERAL

The Ohio State University Antenna Pattern model has been adapted for execution on the ECAC UNIVAC 1110 and the CALCOMP programmable X-Y plotter. Plots were made for the antennas on board the Boeing 747, Boeing 727, Cessna 150, and the F-4H aircraft and are presented as APPENDIX B. The predicted patterns are plotted with solid lines. Where measured patterns are available, they are plotted with dotted lines in the same illustration for purposes of comparison. TABLE 1 summarizes the types of plots and their location in the report. Following each plot is a reproduction of the worksheet used to enter the data.

TABLE 1

LISTING OF FIGURES IN APPENDIX B

Aircraft	Plane of Pattern	Figure	Page
Boeing-747	Roll	B-1	64
Boeing-747	Roll	B-2	66
Boeing-747	Roll	B-3	68
Boeing-747	Elevation	B-4	70
Boeing-747	Azimuth	B-5	72
Boeing-727	Roll	B-6	74
Boeing-727	Elevation	B-7	76
Boeing-727	Azimuth	B-8	78
Cessna-150	Roll	B-9	80
Cessna-150	Elevation	B-10	82
Cessna-150	Azimuth	B-11	84
F-4H	Roll (dB)	B-12	86
	Roll (Field)	B-13	87
F-4H	Elevation (dB)	B-14	89
	Elevation (Field)	B-15	90
F-4H	Azimuth (dB)	B-16	92
	Azimuth (Field)	B-17	93

Using the measured data as a baseline (where available), a statistical analysis was performed, and each plot has been annotated to show the mean error and standard deviation.

CONCLUSION

It is concluded that:

The Ohio State model will provide useful and accurate antenna patterns within the limitations stated below:

a. The model does not provide pattern data fore and aft of the fuselage within volumes defined by 40° cones whose axes are coincident with the longitudinal fuselage axis

b. The model does not account for pattern perturbations caused by:

1) engine nacelles and fairings
2) any part of the landing gear
3) extended flaps
4) the vertical stabilizer.

c. Wings (or horizontal stabilizers) that do not intersect with the fuselage cannot be modeled

d. The model will not provide antenna patterns for antennas that are not fuselage-mounted.

RECOMMENDATION

It is recommended that consideration be given to extending the model to compute the antenna patterns for the voids that presently exist fore and aft of the fuselage.

APPENDIX A

SAMPLE COMPUTER TABULATIONS

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TABLE A-1

BOEING 747 ROLL PLANE E-PHI AND E-THETA TABULATIONS
(Page 1 of 10)

E-PHI PATTERN

ROTATED COORDINATES (THO = 90.00000 , PHO = .00000)

THETA	PHI	E-PHI		PHASE	UNNORMALIZED MAGNITUDE	UNNORMALIZED DB	NORMALIZED MAGNITUDE	NORMALIZED DB
90.00000	.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-566.21910
90.00000	2.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-566.21910
90.00000	4.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-566.21910
90.00000	6.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-566.21910
90.00000	8.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-566.21910
90.00000	10.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-566.21910
90.00000	12.00000	-.00000	.00000	179.44692	.00000	-172.01941	.00000	-138.23851
90.00000	14.00000	-.00000	.00000	179.44692	.00000	-170.17563	.00000	-136.39474
90.00000	16.00000	-.00000	.00000	179.44692	.00000	-168.77798	.00000	-134.99708
90.00000	18.00000	-.00000	.00000	179.44693	.00000	-166.74688	.00000	-132.96599
90.00000	20.00000	-.00000	.00000	179.44692	.00000	-167.09806	.00000	-133.31717
90.00000	22.00000	-.00000	.00000	179.44692	.00000	-166.78622	.00000	-133.00533
90.00000	24.00000	-.00000	.00000	179.44692	.00000	-165.29502	.00000	-131.51413
90.00000	26.00000	-.00000	.00000	179.44693	.00000	-163.92666	.00000	-130.14576
90.00000	28.00000	-.00000	.00000	179.44692	.00000	-164.22775	.00000	-130.44686
90.00000	30.00000	-.00000	.00000	179.44693	.00000	-163.05491	.00000	-129.27402
90.00000	32.00000	-.00000	.00000	179.44693	.00000	-161.96124	.00000	-128.18034
90.00000	34.00000	-.00000	.00000	179.44692	.00000	-162.84706	.00000	-129.06616
90.00000	36.00000	-.00000	.00000	179.44692	.00000	-161.88518	.00000	-128.10428
90.00000	38.00000	-.00000	.00000	179.44693	.00000	-160.97880	.00000	-127.19790
90.00000	40.00000	-.00000	.00000	179.44693	.00000	-160.12240	.00000	-126.34151
90.00000	42.00000	-.00000	.00000	179.44693	.00000	-159.31130	.00000	-125.53041
90.00000	44.00000	-.00000	.00000	179.44693	.00000	-158.54145	.00000	-124.76056
90.00000	46.00000	-.00000	.00000	179.44693	.00000	-157.80935	.00000	-124.02846
90.00000	48.00000	-.00000	.00000	179.44692	.00000	-159.56349	.00000	-125.78255

TABLE A-1

(Page 2 of 10)

90.00000	50.00000	-.00000	.00000	179.44692	.00000	-158.89804	.00000	-125.11716
90.00000	52.00000	-.00000	.00000	179.44693	.00000	-158.26229	.00000	-124.48140
90.00000	54.00000	-.00000	.00000	179.44693	.00000	-157.65910	.00000	-123.87821
90.00000	56.00000	-.00000	.00000	179.44693	.00000	-157.07160	.00000	-123.29071
90.00000	58.00000	-.00000	.00000	179.44693	.00000	-156.51312	.00000	-122.73223
90.00000	60.00000	-.00000	.00000	179.44693	.00000	-165.15040	.00000	-131.36951
90.00000	62.00000	-.00000	.00000	179.44693	.00000	-163.74559	.00000	-129.96470
90.00000	64.00000	-.00000	.00000	179.44693	.00000	-162.51556	.00000	-128.73466
90.00000	66.00000	-.00000	.00000	179.44693	.00000	-161.42092	.00000	-127.64002
90.00000	68.00000	-.00000	.00000	179.44693	.00000	-160.43452	.00000	-126.65363
90.00000	70.00000	-.00000	.00000	179.44693	.00000	-159.53686	.00000	-125.75597
90.00000	72.00000	-.00000	.00000	179.44692	.00000	-156.59527	.00000	-122.81438
90.00000	74.00000	-.00000	.00000	179.44692	.00000	-156.18550	.00000	-122.40460
90.00000	76.00000	-.00000	.00000	179.44692	.00000	-155.79039	.00000	-122.00945
90.00000	78.00000	-.00000	.00000	179.44692	.00000	-163.60806	.00000	-129.82717
90.00000	80.00000	-.00000	.00000	179.44692	.00000	-162.69242	.00000	-128.91152
90.00000	82.00000	-.00000	.00000	179.44692	.00000	-161.85928	.00000	-128.07839
90.00000	84.00000	-.00000	.00000	179.44692	.00000	-161.09554	.00000	-127.31464
90.00000	86.00000	-.00000	.00000	179.44692	.00000	-160.39107	.00000	-126.61018
90.00000	88.00000	-.00000	.00000	179.44692	.00000	-159.73795	.00000	-125.95705
90.00000	90.00000	-.00000	.00000	179.44692	.00000	-159.12980	.00000	-125.34891
90.00000	92.00000	-.00000	.00000	179.44692	.00000	-158.56146	.00000	-124.78057
90.00000	94.00000	-.00000	.00000	179.44692	.00000	-158.02867	.00000	-124.24778
90.00000	96.00000	-.00000	.00000	179.44692	.00000	-157.52787	.00000	-123.74697
90.00000	98.00000	-.00000	.00000	179.44692	.00000	-157.05606	.00000	-123.27517
90.00000	100.00000	-.00000	.00000	179.44692	.00000	-156.61070	.00000	-122.82981
90.00000	102.00000	-.00000	.00000	179.44692	.00000	-156.18961	.00000	-122.40871
90.00000	104.00000	-.00000	.00000	179.44692	.00000	-155.79089	.00000	-122.00999
90.00000	106.00000	-.00000	.00000	179.44692	.00000	-163.61772	.00000	-129.83683
90.00000	108.00000	.00204	.00002	.46613	.00204	-53.82181	.09953	-20.04092
90.00000	110.00000	-.00000	.00000	179.44691	.00000	-161.92169	.00000	-128.14079
90.00000	112.00000	-.00000	.00000	179.44691	.00000	-161.19650	.00000	-127.41561
90.00000	114.00000	-.00000	.00000	179.44691	.00000	-160.53625	.00000	-126.75536
90.00000	116.00000	-.00000	.00000	179.44691	.00000	-159.93180	.00000	-126.15091
90.00000	118.00000	-.00000	.00000	170.96099	.00000	-132.65609	.00001	-98.87520
90.00000	120.00000	-.00000	.00000	171.81089	.00000	-132.62179	.00001	-98.84089
90.00000	122.00000	-.00000	-.00000	-171.95961	.00000	-166.83907	.00000	-133.05817
90.00000	124.00000	-.00000	.00000	179.44691	.00000	-157.99685	.00000	-124.16596
90.00000	126.00000	-.00000	.00000	179.44691	.00000	-157.63676	.00000	-123.76587
90.00000	128.00000	-.00000	.00000	179.44691	.00000	-157.15475	.00000	-123.37386
90.00000	130.00000	-.00000	.00000	179.44689	.00000	-162.16343	.00000	-128.38259
90.00000	132.00000	-.00000	.00000	179.44689	.00000	-161.84989	.00000	-128.06899
90.00000	134.00000	-.00000	.00000	179.44689	.00000	-161.54696	.00000	-127.76607
90.00000	136.00000	-.00000	.00000	179.44689	.00000	-161.26831	.00000	-127.48742
90.00000	138.00000	-.00000	.00000	179.44689	.00000	-161.00777	.00000	-127.22687
90.00000	140.00000	-.00000	.00000	179.44689	.00000	-160.76430	.00000	-126.98341

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TABLE A-1

(Page 3 of 10)

90.00000	142.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	144.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	146.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	148.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	150.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	152.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	154.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	156.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	158.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	160.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	162.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	164.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	166.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	168.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	170.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	172.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	174.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	176.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	178.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	180.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	182.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	184.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	186.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	188.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	190.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	192.00000	-.70050	.00716	179.41408	.70053	-3.09144	.97643	-.20720
90.00000	194.00000	-.69341	.00780	179.19008	.69348	-3.17931	.96660	-.29507
90.00000	196.00000	-.69395	.00435	179.64086	.69396	-3.17328	.96727	-.28905
90.00000	198.00000	-.69758	.00617	179.49313	.69761	-3.12778	.97235	-.24354
90.00000	200.00000	-.69552	.00844	179.30472	.69558	-3.15311	.96952	-.26887
90.00000	202.00000	-.69408	.00661	179.45452	.69411	-3.17141	.96748	-.28717
90.00000	204.00000	-.69564	.00558	179.54032	.69557	-3.15322	.96951	-.26898
90.00000	206.00000	-.69641	.00465	179.45273	.69644	-3.14235	.97072	-.25811
90.00000	208.00000	-.69573	.00746	179.38583	.69577	-3.15072	.96979	-.26649
90.00000	210.00000	-.69498	.00717	179.40910	.69502	-3.16010	.96874	-.27586
90.00000	212.00000	-.69492	.00457	179.45837	.69495	-3.16094	.96865	-.27671
90.00000	214.00000	-.69525	.00628	179.48271	.69528	-3.15686	.96910	-.27262
90.00000	216.00000	-.71624	.04163	176.67374	.71744	-2.88424	1.00000	.00000
90.00000	218.00000	-.68129	.04756	176.00660	.68295	-3.31227	.95192	-.42803
90.00000	220.00000	-.69575	.00665	179.46100	.69578	-3.15056	.96980	-.26634
90.00000	222.00000	-.69573	.00660	179.45679	.69576	-3.15076	.96978	-.26652
90.00000	224.00000	-.69570	.00659	179.45716	.69573	-3.15123	.96973	-.26699
90.00000	226.00000	-.69563	.00655	179.46042	.69566	-3.15202	.96964	-.26778
90.00000	228.00000	-.69553	.00651	179.46340	.69556	-3.15334	.96949	-.26910
90.00000	230.00000	-.69539	.00654	179.46094	.69542	-3.15507	.96930	-.27083
90.00000	232.00000	-.69530	.00648	179.44942	.69533	-3.15618	.96918	-.27194
90.00000	234.00000	-.69538	.00685	179.43590	.69542	-3.15612	.96930	-.27088
90.00000	236.00000	-.69558	.00681	179.43905	.69561	-3.15268	.96957	-.26844

BEST AVAILABLE COPY

TABLE A-1

(Page 4 of 10)

90.00000	238.00000	-.02039	.00174	175.11232	.02046	-33.78089	1.00000	.00000
90.00000	240.00000	.01061	-.00090	-4.90736	.01064	-39.53947	.51531	-5.76858
90.00000	242.00000	.01029	-.00100	-5.59205	.01029	-39.75252	.50283	-5.97163
90.00000	244.00000	.00000	-.00000	-.55305	.00000	-159.93180	.00000	-126.15091
90.00000	246.00000	.00000	-.00000	-.55317	.00000	-160.53626	.00000	-126.75537
90.00000	248.00000	.00000	-.00000	-.55302	.00000	-161.19648	.00000	-127.41559
90.00000	250.00000	.00000	-.00000	-.55322	.00000	-161.92171	.00000	-128.14081
90.00000	252.00000	.00000	.00000	1.56771	.00000	-153.34437	.00000	-119.56348
90.00000	254.00000	.00000	-.00000	-.55341	.00000	-163.61771	.00000	-129.83682
90.00000	256.00000	.00000	-.00000	-.55123	.00000	-155.79151	.00000	-122.01062
90.00000	258.00000	.00000	-.00000	-.54973	.00000	-156.18912	.00000	-122.40823
90.00000	260.00000	.00000	-.00000	-.55652	.00000	-156.61020	.00000	-122.82930
90.00000	262.00000	.00000	-.00000	-.55730	.00000	-157.05646	.00000	-123.27556
90.00000	264.00000	.00000	-.00000	-.55302	.00000	-157.52865	.00000	-123.74776
90.00000	266.00000	.00000	-.00000	-.54939	.00000	-158.02927	.00000	-124.24838
90.00000	268.00000	.00000	-.00000	-.54774	.00000	-158.56178	.00000	-124.78089
90.00000	270.00000	.00000	-.00000	-.54710	.00000	-159.13001	.00000	-125.34912
90.00000	272.00000	.00000	-.00000	-.54691	.00000	-159.73831	.00000	-125.95742
90.00000	274.00000	.00000	-.00000	-.54819	.00000	-160.39187	.00000	-126.61098
90.00000	276.00000	.00000	-.00000	-.55298	.00000	-161.09675	.00000	-127.31586
90.00000	278.00000	.00000	-.00000	-.56067	.00000	-161.85999	.00000	-128.07910
90.00000	280.00000	.00000	-.00000	-.56032	.00000	-162.69136	.00000	-128.91047
90.00000	282.00000	.00000	-.00000	-.54479	.00000	-163.60686	.00000	-129.82597
90.00000	284.00000	.00000	-.00000	-.54930	.00000	-155.79161	.00000	-122.01072
90.00000	286.00000	.00000	-.00000	-.56293	.00000	-156.18520	.00000	-122.40431
90.00000	288.00000	.00000	-.00000	-.54335	.00000	-156.59452	.00000	-122.81363
90.00000	290.00000	.00000	-.00000	-.57003	.00000	-159.53981	.00000	-125.75892
90.00000	292.00000	.00000	-.00000	-.53543	.00000	-160.43065	.00000	-126.64976
90.00000	294.00000	.00000	-.00000	-.57971	.00000	-161.42504	.00000	-127.64415
90.00000	296.00000	.00000	-.00000	-.50898	.00000	-162.51303	.00000	-128.73214
90.00000	298.00000	.00000	-.00000	-.60942	.00000	-163.74255	.00000	-129.96165
90.00000	300.00000	.00000	-.00000	-.53289	.00000	-165.16174	.00000	-131.38084
90.00000	302.00000	.00000	-.00000	-.52097	.00000	-156.50968	.00000	-122.72879
90.00000	304.00000	.00000	-.00000	-.58346	.00000	-157.06628	.00000	-123.28539
90.00000	306.00000	.00000	-.00000	-.59960	.00000	-157.65857	.00000	-123.87768
90.00000	308.00000	.00000	-.00000	-.54146	.00000	-158.27210	.00000	-124.49121
90.00000	310.00000	.00000	-.00000	-.46162	.00000	-158.90317	.00000	-125.12228
90.00000	312.00000	.00000	-.00000	-.46092	.00000	-159.55941	.00000	-125.77852
90.00000	314.00000	.00000	-.00000	-.48689	.00000	-157.79940	.00000	-124.01850
90.00000	316.00000	.00000	-.00000	-.49778	.00000	-158.52627	.00000	-124.74537
90.00000	318.00000	.00000	-.00000	-.49422	.00000	-159.29177	.00000	-125.51088
90.00000	320.00000	.00000	-.00000	-.46011	.00000	-160.09952	.00000	-126.31863
90.00000	322.00000	.00000	-.00000	-.38191	.00000	-160.95679	.00000	-127.17590
90.00000	324.00000	.00000	-.00000	-.27123	.00000	-161.87637	.00000	-128.09547
90.00000	326.00000	.00000	-.00000	-.21985	.00000	-162.87295	.00000	-129.09206
90.00000	328.00000	.00000	-.00000	-.45298	.00000	-162.02089	.00000	-128.24000

BEST AVAILABLE COPY

TABLE A-1

(Page 5 of 10)

90.00000	330.00000	.00000	-.00000	-.92709	.00000	-163.11441	.00000	-129.33352
90.00000	332.00000	.00000	-.00000	-1.29137	.00000	-164.18952	.00000	-130.90863
90.00000	334.00000	.00000	-.00000	-.48851	.00000	-163.79701	.00000	-130.01611
90.00000	336.00000	.00000	.00000	.66750	.00000	-165.28220	.00000	-131.50130
90.00000	338.00000	.00000	-.00000	-.43039	.00000	-167.06003	.00000	-133.27919
90.00000	340.00000	.00000	-.00000	-2.86325	.00000	-167.07604	.00000	-133.29516
90.00000	342.00000	.00000	.00000	.56487	.00000	-166.08682	.00000	-132.30593
90.00000	344.00000	.00000	.00000	6.28702	.00000	-169.37399	.00000	-135.59310
90.00000	346.00000	.00000	-.00000	-11.62550	.00000	-171.05521	.00000	-137.27432
90.00000	348.00000	.00000	-.00000	-1.73273	.00000	-169.42071	.00000	-135.63982
90.00000	350.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-566.21910
90.00000	352.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-566.21910
90.00000	354.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-566.21910
90.00000	356.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-566.21910
90.00000	358.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-566.21910
90.00000	360.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-566.21910

BEST AVAILABLE COPY

TABLE A-1

(Page 6 of 10)

E-THETA PATTERN

ROTATED COORDINATES (THO = 90.00000 , PHO = .00000)

THETA	PHI	E-THETA		PHASE	UNNORMALIZED MAGNITUDE	UNNORMALIZED DB	NORMALIZED MAGNITUDE	NORMALIZED DB
90.00000	.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	2.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	4.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	6.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	8.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	10.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	12.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	14.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	16.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	18.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	20.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	22.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	24.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	26.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	28.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	30.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	32.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	34.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	36.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	38.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	40.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	42.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	44.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	46.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	48.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982

BEST AVAILABLE COPY

TABLE A-1

(Page 7 of 10)

90.00000	50.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	52.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	54.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	56.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	58.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	60.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	62.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	64.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	66.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	68.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	70.00000	-.69547	.00671	179.44693	.69550	-3.15406	.96941	-.26982
90.00000	72.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	74.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	76.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	78.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	80.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	82.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	84.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	86.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	88.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	90.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	92.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	94.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	96.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	98.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	100.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	102.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	104.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	106.00000	-.69547	.00671	179.44692	.69550	-3.15406	.96941	-.26982
90.00000	108.00000	-.69547	.00671	179.44691	.69550	-3.15406	.96941	-.26982
90.00000	110.00000	-.69547	.00671	179.44691	.69550	-3.15406	.96941	-.26982
90.00000	112.00000	-.69547	.00671	179.44691	.69550	-3.15406	.96941	-.26982
90.00000	114.00000	-.69547	.00671	179.44691	.69550	-3.15406	.96941	-.26982
90.00000	116.00000	-.69547	.00671	179.44691	.69550	-3.15406	.96941	-.26982
90.00000	118.00000	-.05234	-.05627	-132.93010	.07686	-22.28689	.10712	-19.40265
90.00000	120.00000	-.04745	-.04893	-134.12101	.06816	-23.32897	.09501	-20.44473
90.00000	122.00000	-.04611	-.04884	-133.35219	.06717	-23.45660	.09362	-20.57236
90.00000	124.00000	-.69547	.00671	179.44691	.69550	-3.15406	.96941	-.26982
90.00000	126.00000	-.69547	.00671	179.44691	.69550	-3.15406	.96941	-.26982
90.00000	128.00000	-.69547	.00671	179.44691	.69550	-3.15406	.96941	-.26982
90.00000	130.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	132.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	134.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	136.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	138.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	140.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982

BEST AVAILABLE COPY

TABLE A-1

(Page 8 of 10)

90.00000	142.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	144.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	146.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	148.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	150.00000	-.69547	.00671	179.44689	.69550	-3.15406	.96941	-.26982
90.00000	152.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	154.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	156.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	158.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	160.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	162.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	164.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	166.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	168.00000	-.69547	.00671	179.44688	.69550	-3.15406	.96941	-.26982
90.00000	170.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	172.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	174.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	176.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	178.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	180.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	182.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	184.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	186.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	188.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	190.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11575
90.00000	192.00000	-.70050	.00716	179.41408	.70053	-3.09144	.97643	-.20720
90.00000	194.00000	-.69341	.00980	179.19008	.69348	-3.17931	.96660	-.29507
90.00000	196.00000	-.69395	.00435	179.64086	.69396	-3.17328	.96727	-.28905
90.00000	198.00000	-.69758	.00617	179.49313	.69761	-3.12778	.97235	-.24354
90.00000	200.00000	-.69552	.00844	179.30472	.69558	-3.15311	.96952	-.26887
90.00000	202.00000	-.69408	.00661	179.45452	.69411	-3.17141	.96748	-.28717
90.00000	204.00000	-.69564	.00558	179.54032	.69557	-3.15322	.96951	-.26898
90.00000	206.00000	-.69641	.00665	179.45273	.69644	-3.14235	.97072	-.25811
90.00000	208.00000	-.69573	.00746	179.38583	.69577	-3.15072	.96979	-.26649
90.00000	210.00000	-.69498	.00717	179.40910	.69502	-3.16010	.96874	-.27586
90.00000	212.00000	-.69492	.00657	179.45837	.69495	-3.16094	.96865	-.27671
90.00000	214.00000	-.69525	.00628	179.48271	.69528	-3.15686	.96910	-.27262
90.00000	216.00000	-.71624	.04163	176.67374	.71744	-2.88424	1.00000	.00000
90.00000	218.00000	-.68129	.04756	176.00660	.68295	-3.31227	.95192	-.42803
90.00000	220.00000	-.69575	.00655	179.46100	.69578	-3.15056	.96980	-.26634
90.00000	222.00000	-.69573	.00660	179.45679	.69576	-3.15076	.96978	-.26652
90.00000	224.00000	-.69570	.00659	179.45716	.69573	-3.15123	.96973	-.26699
90.00000	226.00000	-.69563	.00655	179.46042	.69566	-3.15202	.96964	-.26778
90.00000	228.00000	-.69553	.00651	179.46340	.69556	-3.15334	.96949	-.26910
90.00000	230.00000	-.69539	.00654	179.46094	.69542	-3.15507	.96930	-.27083
90.00000	232.00000	-.69530	.00668	179.44942	.69533	-3.15618	.96918	-.27194
90.00000	234.00000	-.69538	.00685	179.43590	.69542	-3.15512	.96930	-.27088
90.00000	236.00000	-.69558	.00681	179.43905	.69561	-3.15268	.96957	-.26844

BEST AVAILABLE COPY

TABLE A-1

(Page 9 of 10)

90.00000	238.00000	-.04187	-.04915	-130.42707	.06456	-23.80059	.08999	-20.91635
90.00000	240.00000	-.04040	-.04611	-142.64452	.07599	-22.38517	.10591	-19.60093
90.00000	242.00000	-.04235	-.05575	-127.22160	.07001	-23.09659	.09768	-20.21235
90.00000	244.00000	-.69551	.00661	179.45538	.69554	-3.15357	.96947	-.26933
90.00000	246.00000	-.69539	.00679	179.44092	.69543	-3.15499	.96931	-.27076
90.00000	248.00000	-.69555	.00666	179.45152	.69558	-3.15305	.96953	-.26881
90.00000	250.00000	-.69540	.00677	179.44183	.69543	-3.15494	.96931	-.27071
90.00000	252.00000	-.63066	.00716	179.34919	.63070	-4.00351	.87910	-1.11927
90.00000	254.00000	-.69548	.00680	179.43991	.69552	-3.15385	.96949	-.26961
90.00000	256.00000	-.69539	.00668	179.44973	.69542	-3.15501	.96931	-.27077
90.00000	258.00000	-.69552	.00666	179.45176	.69556	-3.15336	.96949	-.26912
90.00000	260.00000	-.69552	.00677	179.44221	.69556	-3.15337	.96949	-.26913
90.00000	262.00000	-.69543	.00678	179.44147	.69546	-3.15457	.96936	-.27033
90.00000	264.00000	-.69539	.00671	179.44699	.69542	-3.15501	.96931	-.27077
90.00000	266.00000	-.69541	.00666	179.45115	.69544	-3.15475	.96934	-.27051
90.00000	268.00000	-.69544	.00664	179.45265	.69547	-3.15440	.96938	-.27016
90.00000	270.00000	-.69545	.00664	179.45290	.69548	-3.15427	.96939	-.27003
90.00000	272.00000	-.69544	.00664	179.45265	.69547	-3.15440	.96938	-.27016
90.00000	274.00000	-.69541	.00666	179.45115	.69544	-3.15475	.96934	-.27051
90.00000	276.00000	-.69539	.00671	179.44699	.69542	-3.15501	.96931	-.27077
90.00000	278.00000	-.69543	.00678	179.44147	.69546	-3.15457	.96936	-.27033
90.00000	280.00000	-.69552	.00677	179.44221	.69556	-3.15337	.96949	-.26913
90.00000	282.00000	-.69552	.00666	179.45176	.69556	-3.15336	.96949	-.26912
90.00000	284.00000	-.69539	.00668	179.44973	.69542	-3.15501	.96931	-.27077
90.00000	286.00000	-.69548	.00680	179.43991	.69552	-3.15385	.96949	-.26961
90.00000	288.00000	-.69551	.00663	179.45350	.69554	-3.15355	.96947	-.26931
90.00000	290.00000	-.69540	.00678	179.44178	.69543	-3.15499	.96931	-.27071
90.00000	292.00000	-.69555	.00656	179.45148	.69558	-3.15305	.96953	-.26881
90.00000	294.00000	-.69539	.00679	179.44088	.69543	-3.15499	.96931	-.27076
90.00000	296.00000	-.69551	.00661	179.45534	.69554	-3.15357	.96947	-.26933
90.00000	298.00000	-.69551	.00683	179.43776	.69554	-3.15357	.96947	-.26933
90.00000	300.00000	-.69535	.00668	179.44955	.69538	-3.15557	.96929	-.27133
90.00000	302.00000	-.69555	.00661	179.45592	.69558	-3.15309	.96952	-.26885
90.00000	304.00000	-.69558	.00681	179.43901	.69561	-3.15268	.96957	-.26844
90.00000	306.00000	-.69538	.00685	179.43586	.69542	-3.15512	.96930	-.27088
90.00000	308.00000	-.69530	.00668	179.44938	.69533	-3.15618	.96918	-.27194
90.00000	310.00000	-.69539	.00654	179.46096	.69542	-3.15507	.96930	-.27083
90.00000	312.00000	-.69553	.00651	179.46341	.69556	-3.15334	.96949	-.26910
90.00000	314.00000	-.69563	.00655	179.46049	.69566	-3.15202	.96964	-.26778
90.00000	316.00000	-.69570	.00659	179.45722	.69573	-3.15123	.96973	-.26699
90.00000	318.00000	-.69573	.00660	179.45685	.69576	-3.15076	.96978	-.26652
90.00000	320.00000	-.69575	.00654	179.46106	.69578	-3.15058	.96980	-.26639
90.00000	322.00000	-.69571	.00643	179.47028	.69574	-3.15106	.96975	-.26682
90.00000	324.00000	-.69556	.00630	179.48121	.69558	-3.15300	.96953	-.26876
90.00000	326.00000	-.69525	.00628	179.48276	.69528	-3.15686	.96910	-.27262
90.00000	328.00000	-.69492	.00657	179.45840	.69495	-3.16094	.96865	-.27671

BEST AVAILABLE COPY

TABLE A-1

(Page 10 of 10)

90.00000	330.00000	-.69498	.00717	179.40912	.69502	-3.16010	.96874	-.27586
90.00000	332.00000	-.69573	.00746	179.38585	.69577	-3.15073	.96979	-.26649
90.00000	334.00000	-.69641	.00665	179.45278	.69644	-3.14235	.97072	-.25811
90.00000	336.00000	-.69554	.00558	179.54036	.69557	-3.15322	.96951	-.26898
90.00000	338.00000	-.69408	.00661	179.45456	.69411	-3.17141	.96748	-.28717
90.00000	340.00000	-.69552	.00844	179.30478	.69558	-3.15311	.96952	-.26887
90.00000	342.00000	-.69758	.00617	179.49319	.69761	-3.12778	.97236	-.24354
90.00000	344.00000	-.69395	.00435	179.64092	.69396	-3.17328	.96727	-.28905
90.00000	346.00000	-.69341	.00980	179.19015	.69348	-3.17931	.96660	-.29507
90.00000	348.00000	-.70050	.00716	179.41412	.70053	-3.09144	.97643	-.20720
90.00000	350.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11576
90.00000	352.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11576
90.00000	354.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11576
90.00000	356.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11576
90.00000	358.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11576
90.00000	360.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-597.11576

BEST AVAILABLE COPY

TABLE A-2

BOEING 747 ELEVATION PLANE E-PHI AND E-THETA TABULATIONS
(Page 1 of 10)

E-PHI PATTERN

ROTATED COORDINATES (THO = 90.00000 , PHO = 90.00000)

THETA	PHI	E-PHI		PHASE	UNNORMALIZED MAGNITUDE	UNNORMALIZED DB	NORMALIZED MAGNITUDE	NORMALIZED DB
89.00000	.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	2.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	4.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	6.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	8.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	10.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	12.00000	-.01168	.00201	170.22421	.01186	-38.52137	.01213	-38.31928
89.00000	14.00000	.00321	-.00802	-68.19812	.00864	-41.27006	.00884	-41.06797
89.00000	16.00000	.00368	.00539	55.64275	.00652	-43.71096	.00668	-43.50888
89.00000	18.00000	-.00506	-.00018	-177.98462	.00506	-45.91386	.00518	-45.71177
89.00000	20.00000	.00264	-.00302	-48.81781	.00401	-47.92704	.00411	-47.72495
89.00000	22.00000	.00037	.00322	83.40477	.00324	-49.78544	.00332	-49.58335
89.00000	24.00000	-.00207	-.00167	-141.05748	.00266	-51.51512	.00272	-51.31303
89.00000	26.00000	.00220	-.00007	-1.94704	.00220	-53.13618	.00226	-52.93410
89.00000	28.00000	-.00144	.00116	140.99063	.00185	-54.66438	.00189	-54.46230
89.00000	30.00000	.00048	-.00149	-71.99215	.00156	-56.11241	.00160	-55.91033
89.00000	32.00000	.00025	.00131	79.35228	.00133	-57.49066	.00137	-57.28858
89.00000	34.00000	-.00065	-.00094	-124.73127	.00115	-58.80783	.00117	-58.60575
89.00000	36.00000	.00080	.00058	35.99632	.00099	-60.07127	.00102	-59.86919
89.00000	38.00000	-.00080	-.00032	-158.22997	.00086	-61.28733	.00088	-61.08524
89.00000	40.00000	.00073	.00017	12.81879	.00075	-62.46159	.00077	-62.25950
89.00000	42.00000	-.00065	-.00011	-170.63328	.00066	-63.59904	.00068	-63.39695
89.00000	44.00000	.00057	.00012	11.63090	.00058	-64.70421	.00060	-64.50212
89.00000	46.00000	-.00048	-.00017	-160.08331	.00051	-65.78998	.00053	-65.58789
89.00000	48.00000	.00037	.00026	34.42015	.00045	-66.85958	.00046	-66.65749

BEST AVAILABLE COPY

TABLE A-2

(Page 2 of 10)

89.00000	50.00000	-.00023	-.00033	-124.75588	.00040	-67.90829	.00041	-67.70621
89.00000	52.00000	.00005	.00035	82.57901	.00036	-68.93998	.00037	-68.73790
89.00000	54.00000	.00014	-.00028	-63.39311	.00032	-69.95869	.00033	-69.75661
89.00000	56.00000	-.00026	.00011	157.50231	.00028	-70.96856	.00029	-70.76647
89.00000	58.00000	.00023	.00011	25.43155	.00025	-71.97413	.00026	-71.77204
89.00000	60.00000	-.00004	-.00022	-99.44721	.00022	-72.98039	.00023	-72.77830
89.00000	62.00000	-.00016	.00012	143.01538	.00020	-73.99299	.00020	-73.79090
89.00000	64.00000	.00015	.00010	32.96015	.00018	-75.01849	.00018	-74.81641
89.00000	66.00000	.00006	-.00015	-69.48091	.00016	-76.06476	.00016	-75.86268
89.00000	68.00000	-.00013	-.00004	-164.18548	.00014	-77.14145	.00014	-76.93937
89.00000	70.00000	-.00004	.00012	108.96028	.00012	-78.26066	.00013	-78.05857
89.00000	72.00000	.00009	.00005	30.06046	.00011	-79.43810	.00011	-79.23601
89.00000	74.00000	.00007	-.00006	-40.79042	.00009	-80.69481	.00009	-80.49272
89.00000	76.00000	-.00002	-.00008	-103.50729	.00008	-82.05998	.00008	-81.85789
89.00000	78.00000	-.00006	-.00002	-158.01497	.00007	-83.57625	.00007	-83.37416
89.00000	80.00000	-.00005	.00002	155.75209	.00005	-85.30958	.00006	-85.10749
89.00000	82.00000	-.00002	.00004	117.84919	.00004	-87.36995	.00004	-87.16787
89.00000	84.00000	.00000	.00003	88.32183	.00003	-89.96352	.00003	-89.76143
89.00000	86.00000	.00001	.00002	67.20552	.00002	-93.55301	.00002	-93.35093
89.00000	88.00000	.00001	.00001	54.52557	.00001	-99.61397	.00001	-99.41189
89.00000	90.00000	.00000	.00000	50.29723	.00000	-191.29880	.00000	-191.09671
89.00000	92.00000	-.00001	-.00001	-125.47442	.00001	-99.61443	.00001	-99.41234
89.00000	94.00000	-.00001	-.00002	-112.79446	.00002	-93.55324	.00002	-93.35115
89.00000	96.00000	-.00000	-.00003	-91.67817	.00003	-89.96374	.00003	-89.76165
89.00000	98.00000	.00002	-.00004	-62.15080	.00004	-87.37006	.00004	-87.16798
89.00000	100.00000	.00005	-.00002	-24.24793	.00005	-85.30968	.00006	-85.10759
89.00000	102.00000	.00006	.00002	21.98508	.00007	-83.57636	.00007	-83.37427
89.00000	104.00000	.00002	.00008	76.49272	.00008	-82.06004	.00008	-81.85795
89.00000	106.00000	-.00007	.00006	139.20958	.00009	-80.69486	.00009	-80.49278
89.00000	108.00000	-.00009	-.00005	-149.93947	.00011	-79.43817	.00011	-79.23608
89.00000	110.00000	.00004	-.00012	-71.03975	.00012	-78.26073	.00013	-78.05864
89.00000	112.00000	.00013	.00004	15.81466	.00014	-77.14152	.00014	-76.93943
89.00000	114.00000	-.00006	.00015	110.51908	.00016	-76.06480	.00016	-75.86271
89.00000	116.00000	-.00015	-.00010	-147.03973	.00018	-75.01853	.00018	-74.81644
89.00000	118.00000	.00014	-.00026	-62.26905	.00029	-70.73792	.00030	-70.53584
89.00000	120.00000	-.00005	.00010	116.61832	.00011	-79.41702	.00011	-79.21494
89.00000	122.00000	-.00027	-.00027	-135.10298	.00038	-68.41779	.00039	-68.21570
89.00000	124.00000	.00026	-.00011	-22.49747	.00028	-70.96859	.00029	-70.76650
89.00000	126.00000	-.00014	.00028	116.60698	.00032	-69.95871	.00033	-69.75662
89.00000	128.00000	-.00005	-.00035	-97.42091	.00036	-68.94002	.00037	-68.73793
89.00000	130.00000	.00023	.00033	55.24410	.00040	-67.90833	.00041	-67.70624
89.00000	132.00000	-.00037	-.00026	-145.57987	.00045	-66.85961	.00046	-66.65753
89.00000	134.00000	.00048	.00017	19.91674	.00051	-65.79000	.00053	-65.58792
89.00000	136.00000	-.00057	-.00012	-168.36900	.00058	-64.70424	.00060	-64.50216
89.00000	138.00000	.00065	.00011	9.36692	.00066	-63.59904	.00068	-63.39696
89.00000	140.00000	-.00073	-.00017	-167.18101	.00075	-62.46161	.00077	-62.25952

BEST AVAILABLE COPY

TABLE A-2

(Page 3 of 10)

89.00000	142.00000	.00080	.00032	21.76995	.00086	-61.28736	.00088	-61.08527
89.00000	144.00000	-.00080	-.00058	-144.00358	.00099	-60.07129	.00102	-59.86920
89.00000	146.00000	.00065	.00094	55.26882	.00115	-58.80786	.00117	-58.60578
89.00000	148.00000	-.00025	-.00131	-100.64762	.00133	-57.49069	.00137	-57.28860
89.00000	150.00000	-.00048	.00149	108.00785	.00156	-56.11243	.00160	-55.91034
89.00000	152.00000	.00144	-.00116	-39.00921	.00185	-54.66441	.00189	-54.46232
89.00000	154.00000	-.00220	.00007	178.05301	.00220	-53.13620	.00226	-52.93411
89.00000	156.00000	.00207	.00167	38.94283	.00266	-51.51515	.00272	-51.31307
89.00000	158.00000	-.00037	-.00322	-96.59525	.00324	-49.78546	.00332	-49.58337
89.00000	160.00000	-.00264	.00302	131.18208	.00401	-47.92706	.00411	-47.72497
89.00000	162.00000	.00506	.00018	2.01548	.00506	-45.91388	.00518	-45.71179
89.00000	164.00000	-.00368	-.00538	-124.35739	.00652	-43.71100	.00668	-43.50891
89.00000	166.00000	-.00321	.00802	111.80153	.00864	-41.27008	.00884	-41.06799
89.00000	168.00000	.01168	-.00201	-9.77604	.01186	-38.52140	.01213	-38.31931
89.00000	170.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	172.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	174.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	176.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	178.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	180.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	182.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	184.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	186.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	188.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	190.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	192.00000	-.02652	-.97664	-91.55560	.97700	-.20209	1.00000	.00000
89.00000	194.00000	.32948	.91188	70.13427	.96958	-.26831	.99240	-.06623
89.00000	196.00000	-.61206	-.74045	-129.57726	.96067	-.34855	.98328	-.14646
89.00000	198.00000	.83044	.46250	29.11473	.95055	-.44051	.97292	-.23843
89.00000	200.00000	-.93411	-.09846	-173.98308	.93928	-.54409	.96139	-.34201
89.00000	202.00000	.87602	-.30270	-19.06208	.92684	-.65986	.94866	-.45777
89.00000	204.00000	-.63083	.66038	133.68920	.91326	-.78808	.93476	-.58599
89.00000	206.00000	.21867	-.87155	-75.91552	.89856	-.92905	.91971	-.72697
89.00000	208.00000	.27365	.83927	71.94075	.88275	-1.08321	.90353	-.88112
89.00000	210.00000	-.69080	-.52203	-142.92227	.86586	-1.25101	.88624	-1.04893
89.00000	212.00000	.84785	-.01009	-.68150	.84791	-1.43299	.86787	-1.23091
89.00000	214.00000	-.62073	.54937	138.48999	.82892	-1.62975	.84843	-1.42766
89.00000	216.00000	.06238	-.80651	-85.57744	.80891	-1.84195	.82795	-1.63987
89.00000	218.00000	.53786	.57578	46.95036	.78792	-2.07038	.80646	-1.86829
89.00000	220.00000	-.76401	.05460	175.91226	.76596	-2.31589	.78399	-2.11381
89.00000	222.00000	.38442	-.63599	-58.84909	.74314	-2.57853	.76064	-2.37644
89.00000	224.00000	.33200	.63814	62.51383	.71934	-2.86132	.73627	-2.65923
89.00000	226.00000	-.69466	.00178	179.85328	.69466	-3.16457	.71101	-2.96249
89.00000	228.00000	.26173	-.61582	-66.97395	.66913	-3.48978	.68488	-3.28770
89.00000	230.00000	.47848	.42923	41.89440	.64279	-3.83865	.65792	-3.63656
89.00000	232.00000	-.51235	.34137	146.32564	.61566	-4.21316	.63015	-4.01107
89.00000	234.00000	-.23727	-.53777	-113.80748	.58779	-4.61563	.60162	-4.41354
89.00000	236.00000	.52990	-.17860	-18.62639	.55919	-5.04877	.57236	-4.84668

BEST AVAILABLE COPY

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TABLE A-2

(Page 4 of 10)

89.00000	238.00000	.16593	.50311	71.74722	.52976	-5.51839	.54223	-5.31630
89.00000	240.00000	-.46091	.19372	157.20255	.49996	-6.02121	.51173	-5.81913
89.00000	242.00000	-.25115	-.39681	-122.33134	.46961	-6.56525	.48066	-6.36316
89.00000	244.00000	.29901	-.32057	-46.99327	.43837	-7.16316	.44869	-6.96107
89.00000	246.00000	.37402	.15982	23.13719	.40674	-7.81373	.41631	-7.61165
89.00000	248.00000	.01323	.37437	87.97634	.37461	-8.52849	.38342	-8.32640
89.00000	250.00000	-.28828	.18404	147.44494	.34202	-9.31897	.35007	-9.11688
89.00000	252.00000	-.28757	-.11311	-158.52940	.30902	-10.20035	.31629	-9.99827
89.00000	254.00000	-.09433	-.25899	-110.01233	.27564	-11.19324	.28213	-10.99115
89.00000	256.00000	.09428	-.22279	-67.06317	.24192	-12.32649	.24762	-12.12441
89.00000	258.00000	.18054	-.10312	-29.73411	.20791	-13.64242	.21281	-13.44033
89.00000	260.00000	.17355	.00585	1.92933	.17365	-15.20659	.17774	-15.00451
89.00000	262.00000	.12301	.06510	27.88853	.13917	-17.12889	.14245	-16.92680
89.00000	264.00000	.06979	.07782	48.11190	.10453	-19.61530	.10699	-19.41322
89.00000	266.00000	.03213	.06192	62.57474	.06976	-23.12830	.07140	-22.92621
89.00000	268.00000	.01121	.03305	71.25957	.03490	-29.14361	.03572	-28.94152
89.00000	270.00000	.00000	.00000	74.15568	.00000	-169.38482	.00000	-169.18274
89.00000	272.00000	-.01121	-.03305	-108.74042	.03490	-29.14364	.03572	-28.94155
89.00000	274.00000	-.03213	-.06192	-117.42525	.06976	-23.12832	.07140	-22.92623
89.00000	276.00000	-.06979	-.07782	-131.88804	.10453	-19.61531	.10699	-19.41323
89.00000	278.00000	-.12301	-.06510	-152.11141	.13917	-17.12890	.14245	-16.92681
89.00000	280.00000	-.17355	-.00585	-178.07056	.17365	-15.20660	.17774	-15.00451
89.00000	282.00000	-.18054	.10312	150.26605	.20791	-13.64242	.21281	-13.44034
89.00000	284.00000	-.09428	.22279	112.93704	.24192	-12.32650	.24762	-12.12441
89.00000	286.00000	.09433	.25899	69.98783	.27564	-11.19324	.28213	-10.99115
89.00000	288.00000	.28757	.11311	21.47076	.30902	-10.20035	.31629	-9.99827
89.00000	290.00000	.28828	-.18404	-32.55489	.34202	-9.31897	.35007	-9.11688
89.00000	292.00000	-.01323	-.37437	-92.02355	.37461	-8.52849	.38342	-8.32641
89.00000	294.00000	-.37402	-.15982	-156.86259	.40674	-7.81374	.41631	-7.61165
89.00000	296.00000	-.29901	.32057	133.00700	.43837	-7.16316	.44869	-6.96108
89.00000	298.00000	.25107	.39670	57.67050	.46947	-6.56782	.48052	-6.36573
89.00000	300.00000	.46100	-.19360	-22.78022	.50000	-6.02060	.51177	-5.81851
89.00000	302.00000	-.16593	-.50327	-108.24708	.52992	-5.51581	.54239	-5.31372
89.00000	304.00000	-.52990	.17860	161.37394	.55919	-5.04877	.57236	-4.84668
89.00000	306.00000	.23726	.53777	66.19290	.58779	-4.61563	.60162	-4.41354
89.00000	308.00000	.51236	-.34136	-33.67392	.61566	-4.21316	.63015	-4.01108
89.00000	310.00000	-.47847	-.42923	-138.10518	.64279	-3.83865	.65792	-3.63657
89.00000	312.00000	-.26173	.61582	113.02638	.66913	-3.48978	.68488	-3.28770
89.00000	314.00000	.69466	-.00177	-.14636	.69466	-3.16458	.71101	-2.96249
89.00000	316.00000	-.33199	-.63815	-117.48562	.71934	-2.86132	.73627	-2.65923
89.00000	318.00000	-.38443	.63599	121.15123	.74314	-2.57853	.76064	-2.37645
89.00000	320.00000	.76401	-.05459	-4.08728	.76596	-2.31589	.78399	-2.11381
89.00000	322.00000	-.53785	-.57579	-133.04917	.78792	-2.07038	.80646	-1.86829
89.00000	324.00000	-.06238	.80651	94.42281	.80891	-1.84195	.82795	-1.63987
89.00000	326.00000	.62073	-.54936	-41.50954	.82892	-1.62975	.84843	-1.42766
89.00000	328.00000	-.84785	.01008	179.31902	.84791	-1.43299	.86787	-1.23091

TABLE A-2

(Page 5 of 10)

89.00000	330.00000	.69080	.52203	37.07831	.86586	-1.25101	.88624	-1.04893
89.00000	332.00000	-.27365	-.83927	-108.05884	.88275	-1.08321	.90353	-.88112
89.00000	334.00000	-.21868	.87155	104.08518	.89856	-.92905	.91971	-.72697
89.00000	336.00000	.63084	-.66037	-46.31023	.91326	-.78808	.93476	-.58599
89.00000	338.00000	-.87602	.30269	160.93830	.92684	-.65986	.94866	-.45777
89.00000	340.00000	.93411	.09846	6.01737	.93928	-.54410	.96139	-.34201
89.00000	342.00000	-.83044	-.46251	-150.88469	.95055	-.44051	.97292	-.23843
89.00000	344.00000	.61205	.74045	50.42317	.96067	-.34855	.98328	-.14646
89.00000	346.00000	-.32947	-.91189	-109.86529	.96958	-.26831	.99240	-.06623
89.00000	348.00000	.02651	.97664	88.44504	.97700	-.20209	1.00000	-.00000
89.00000	350.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	352.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	354.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	356.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	358.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790
89.00000	360.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-599.79790

BEST AVAILABLE COPY

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TABLE A-2

(Page 6 of 10)

E-THETA PATTERN

ROTATED COORDINATES (THO = 90.00000 , PHO = 90.00000)

THETA	PHI	E-THETA		PHASE	UNNORMALIZED MAGNITUDE	UNNORMALIZED DB	NORMALIZED MAGNITUDE	NORMALIZED DB
89.00000	.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	2.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	4.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	6.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	8.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	10.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	12.00000	-.14230	.02452	170.22421	.14439	-16.80900	1.00000	.00000
89.00000	14.00000	.04584	-.11460	-68.19813	.12343	-18.17175	.85480	-1.36275
89.00000	16.00000	.06048	.08848	55.64275	.10717	-19.39816	.74224	-2.58916
89.00000	18.00000	-.09418	-.00331	-177.98462	.09424	-20.51546	.65265	-3.70646
89.00000	20.00000	.05513	-.06301	-48.81780	.08373	-21.54284	.57984	-4.73384
89.00000	22.00000	.00862	.07454	83.40477	.07504	-22.49437	.51967	-5.68536
89.00000	24.00000	-.05270	-.04259	-141.05748	.06776	-23.38058	.46927	-6.57158
89.00000	26.00000	.06156	-.00209	-1.94704	.06159	-24.20967	.42655	-7.40067
89.00000	28.00000	-.04376	.03545	140.99062	.05631	-24.98802	.38999	-8.17902
89.00000	30.00000	.01600	-.04922	-71.99215	.05176	-25.72075	.35844	-8.91175
89.00000	32.00000	.00883	.04697	79.35227	.04780	-26.41200	.33102	-9.60300
89.00000	34.00000	-.02526	-.03644	-124.73128	.04433	-27.06521	.30704	-10.25621
89.00000	36.00000	.03341	.02427	35.99631	.04129	-27.68317	.28595	-10.87417
89.00000	38.00000	-.03585	-.01432	-158.22998	.03860	-28.26826	.26732	-11.45926
89.00000	40.00000	.03531	.00803	12.81879	.03621	-28.82244	.25080	-12.01344
89.00000	42.00000	-.03364	-.00555	-170.63329	.03409	-29.34741	.23609	-12.53841
89.00000	44.00000	.03153	.00649	11.63090	.03219	-29.84460	.22296	-13.03559
89.00000	46.00000	-.02864	-.01038	-160.08331	.03047	-30.32385	.21099	-13.51485
89.00000	48.00000	.02383	.01633	34.42013	.02889	-30.78546	.20007	-13.97646

TABLE A-2

(Page 7 of 10)

89.00000	50.00000	-.01566	-.02257	-124.75589	.02747	-31.22169	.19027	-14.41269
89.00000	52.00000	.00338	.02598	82.57899	.02620	-31.63332	.18146	-14.82431
89.00000	54.00000	.01122	-.02240	-63.39311	.02506	-32.02104	.17354	-15.21203
89.00000	56.00000	-.02220	.00919	157.50231	.02403	-32.38544	.16641	-15.57644
89.00000	58.00000	.02086	.00992	25.43155	.02310	-32.72705	.15999	-15.91805
89.00000	60.00000	-.00366	-.02197	-99.44721	.02227	-33.04631	.15422	-16.23731
89.00000	62.00000	-.01719	.01295	143.01537	.02152	-33.34360	.14903	-16.53460
89.00000	64.00000	.01749	.01134	32.96014	.02085	-33.61927	.14437	-16.81026
89.00000	66.00000	.00710	-.01896	-69.48093	.02025	-33.87358	.14021	-17.06458
89.00000	68.00000	-.01896	-.00537	-164.18549	.01971	-34.10680	.13649	-17.29780
89.00000	70.00000	-.00625	.01819	108.96027	.01923	-34.31914	.13320	-17.51013
89.00000	72.00000	.01628	.00942	30.06044	.01881	-34.51078	.13029	-17.70178
89.00000	74.00000	.01397	-.01205	-40.79043	.01845	-34.68188	.12775	-17.87288
89.00000	76.00000	-.00423	-.01763	-103.50729	.01813	-34.83256	.12555	-18.02356
89.00000	78.00000	-.01656	-.00669	-158.01499	.01786	-34.96294	.12368	-18.15393
89.00000	80.00000	-.01608	.00724	155.75207	.01763	-35.07313	.12212	-18.26413
89.00000	82.00000	-.00815	.01543	117.84919	.01745	-35.16318	.12086	-18.35418
89.00000	84.00000	.00051	.01730	88.32182	.01731	-35.23316	.11989	-18.42416
89.00000	86.00000	.00667	.01587	67.20550	.01721	-35.28311	.11921	-18.47411
89.00000	88.00000	.00995	.01397	54.52555	.01715	-35.31307	.11879	-18.50407
89.00000	90.00000	.01094	.01318	50.29723	.01713	-35.32306	.11866	-18.51405
89.00000	92.00000	.00995	.01397	54.52555	.01715	-35.31307	.11879	-18.50407
89.00000	94.00000	.00667	.01587	67.20552	.01721	-35.28311	.11921	-18.47411
89.00000	96.00000	.00051	.01730	88.32182	.01731	-35.23316	.11989	-18.42416
89.00000	98.00000	-.00815	.01543	117.84919	.01745	-35.16318	.12086	-18.35418
89.00000	100.00000	-.01608	.00724	155.75206	.01763	-35.07313	.12212	-18.26413
89.00000	102.00000	-.01656	-.00669	-158.01493	.01786	-34.96294	.12368	-18.15393
89.00000	104.00000	-.00423	-.01763	-103.50728	.01813	-34.83256	.12555	-18.02356
89.00000	106.00000	.01397	-.01205	-40.79043	.01845	-34.68188	.12775	-17.87288
89.00000	108.00000	.01628	.00942	30.06051	.01881	-34.51078	.13029	-17.70178
89.00000	110.00000	-.00625	.01819	108.96024	.01923	-34.31914	.13320	-17.51014
89.00000	112.00000	-.01896	-.00537	-164.18534	.01971	-34.10681	.13649	-17.29781
89.00000	114.00000	.00710	-.01896	-69.48093	.02025	-33.87358	.14021	-17.06458
89.00000	116.00000	.01749	.01134	32.96025	.02085	-33.61927	.14437	-16.81027
89.00000	118.00000	-.01457	.02771	117.73098	.03130	-30.08851	.21678	-13.27951
89.00000	120.00000	.00476	-.00949	-63.38176	.01061	-39.48291	.07350	-22.67391
89.00000	122.00000	.02465	.02456	44.89700	.03479	-29.17071	.24094	-12.36170
89.00000	124.00000	-.02220	.00919	157.50252	.02403	-32.38544	.16641	-15.57644
89.00000	126.00000	.01122	-.02240	-63.39302	.02506	-32.02104	.17354	-15.21203
89.00000	128.00000	.00338	.02598	82.57909	.02620	-31.63332	.18146	-14.82432
89.00000	130.00000	-.01566	-.02257	-124.75590	.02747	-31.22169	.19027	-14.41269
89.00000	132.00000	.02383	.01633	34.42012	.02889	-30.78547	.20007	-13.97647
89.00000	134.00000	-.02864	-.01038	-160.08326	.03047	-30.32385	.21099	-13.51485
89.00000	136.00000	.03153	.00649	11.63100	.03219	-29.84460	.22296	-13.03560
89.00000	138.00000	-.03364	-.00555	-170.63309	.03409	-29.34741	.23609	-12.53841
89.00000	140.00000	.03531	.00803	12.81898	.03621	-28.82245	.25080	-12.01345

BEST AVAILABLE COPY

BEST AVAILABLE COPY

TABLE A-2

(Page 8 of 10)

89.00000	142.00000	-.03585	-.01432	-158.23006	.03860	-28.26826	.26732	-11.45926
89.00000	144.00000	.03341	.02427	35.99641	.04129	-27.68318	.28595	-10.87418
89.00000	146.00000	-.02526	-.03644	-124.73118	.04433	-27.06522	.30704	-10.25622
89.00000	148.00000	.00883	.04697	79.35238	.04780	-26.41201	.33102	-9.60301
89.00000	150.00000	.01600	-.04922	-71.99215	.05176	-25.72075	.35844	-8.91175
89.00000	152.00000	-.04376	.03545	140.99079	.05631	-24.98802	.38999	-8.17902
89.00000	154.00000	.06156	-.00209	-1.94699	.06159	-24.20967	.42655	-7.40067
89.00000	156.00000	-.05270	-.04259	-141.05718	.06776	-23.38059	.46927	-6.57159
89.00000	158.00000	.00862	.07454	83.40474	.07504	-22.49437	.51967	-5.68537
89.00000	160.00000	.05513	-.06301	-48.81792	.08373	-21.54284	.57984	-4.73384
89.00000	162.00000	-.09418	-.00331	-177.98452	.09424	-20.51546	.65264	-3.70646
89.00000	164.00000	.06048	.08848	55.64260	.10717	-19.39817	.74224	-2.58917
89.00000	166.00000	.04584	-.11460	-68.19847	.12343	-18.17176	.85480	-1.36276
89.00000	168.00000	-.14230	.02452	170.22396	.14439	-16.80901	1.00000	-.00001
89.00000	170.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	172.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	174.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	176.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	178.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	180.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	182.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	184.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	186.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	188.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	190.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	192.00000	-.00010	-.00362	-91.55559	.00362	-48.81550	.02510	-32.00650
89.00000	194.00000	.00143	.00397	70.13427	.00422	-47.49579	.02922	-30.68679
89.00000	196.00000	-.00306	-.00371	-129.57727	.00481	-46.36152	.03329	-29.55251
89.00000	198.00000	.00471	.00262	29.11473	.00539	-45.36791	.03733	-28.55891
89.00000	200.00000	-.00593	-.00063	-173.98308	.00597	-44.48570	.04132	-27.67670
89.00000	202.00000	.00618	-.00213	-19.06208	.00654	-43.69458	.04526	-26.88558
89.00000	204.00000	-.00490	.00513	133.68920	.00710	-42.97933	.04915	-26.17033
89.00000	206.00000	.00186	-.00742	-75.91552	.00765	-42.32832	.05297	-25.51932
89.00000	208.00000	.00254	.00779	71.94075	.00819	-41.73262	.05673	-24.92362
89.00000	210.00000	-.00696	-.00526	-142.92227	.00872	-41.18513	.06042	-24.37612
89.00000	212.00000	.00925	-.00011	-.68150	.00925	-40.68010	.06404	-23.87110
89.00000	214.00000	-.00731	.00647	138.48999	.00976	-40.21289	.06758	-23.40389
89.00000	216.00000	.00079	-.01023	-85.57744	.01026	-39.77963	.07103	-22.97063
89.00000	218.00000	.00733	.00785	46.95036	.01074	-39.37709	.07440	-22.56809
89.00000	220.00000	-.01119	.00080	175.91226	.01122	-39.00253	.07768	-22.19353
89.00000	222.00000	.00604	-.00999	-58.84909	.01168	-38.65268	.08088	-21.84368
89.00000	224.00000	.00560	.01075	62.51383	.01212	-38.32748	.08396	-21.51848
89.00000	226.00000	-.01255	.00003	179.85328	.01255	-38.02421	.08694	-21.21521
89.00000	228.00000	.00507	-.01194	-66.97395	.01297	-37.74143	.08982	-20.93243
89.00000	230.00000	.00995	.00893	41.89440	.01337	-37.47782	.09259	-20.66882
89.00000	232.00000	-.01145	.00763	146.32565	.01375	-37.23225	.09524	-20.42325
89.00000	234.00000	-.00570	-.01292	-113.80748	.01412	-37.00374	.09778	-20.19474
89.00000	236.00000	.01371	-.00462	-18.62639	.01447	-36.79141	.10020	-19.98241

TABLE A-2

(Page 9 of 10)

89.00000	238.00000	.00434	-.00106	-13.69571	.00447	-47.00137	.03093	-30.19237
89.00000	240.00000	-.00504	.01799	105.64476	.01868	-34.57298	.12936	-17.76398
89.00000	242.00000	-.01740	-.02489	-124.94763	.03037	-30.35127	.21032	-13.54227
89.00000	244.00000	.01070	-.01147	-46.99328	.01569	-36.08969	.10863	-19.28069
89.00000	246.00000	.01466	.00626	23.13719	.01594	-35.94829	.11042	-19.13929
89.00000	248.00000	.00057	.01617	87.97634	.01618	-35.81958	.11207	-19.01058
89.00000	250.00000	-.01382	.00882	147.44494	.01640	-35.70318	.11358	-18.89418
89.00000	252.00000	-.01545	-.00608	-158.52941	.01660	-35.59877	.11495	-18.78977
89.00000	254.00000	-.00574	-.01576	-110.01233	.01678	-35.50607	.11618	-18.69707
89.00000	256.00000	.00660	-.01560	-67.06317	.01693	-35.42481	.11728	-18.61581
89.00000	258.00000	.01482	-.00847	-29.73411	.01707	-35.35481	.11823	-18.54581
89.00000	260.00000	.01718	.00058	1.92933	.01719	-35.29587	.11903	-18.48687
89.00000	262.00000	.01528	.00808	27.88853	.01728	-35.24784	.11969	-18.43884
89.00000	264.00000	.01159	.01292	48.11190	.01736	-35.21061	.12020	-18.40161
89.00000	266.00000	.00802	.01545	62.57474	.01741	-35.18408	.12057	-18.37508
89.00000	268.00000	.00560	.01652	71.25957	.01744	-35.16819	.12079	-18.35919
89.00000	270.00000	.00476	.01679	74.15568	.01745	-35.16290	.12087	-18.35390
89.00000	272.00000	.00560	.01652	71.25957	.01744	-35.16819	.12079	-18.35919
89.00000	274.00000	.00802	.01545	62.57474	.01741	-35.18408	.12057	-18.37508
89.00000	276.00000	.01159	.01292	48.11195	.01736	-35.21061	.12020	-18.40161
89.00000	278.00000	.01528	.00808	27.88858	.01728	-35.24784	.11969	-18.43884
89.00000	280.00000	.01718	.00058	1.92944	.01719	-35.29587	.11903	-18.48687
89.00000	282.00000	.01482	-.00847	-29.73395	.01707	-35.35481	.11823	-18.54581
89.00000	284.00000	.00660	-.01560	-67.06296	.01693	-35.42482	.11728	-18.61582
89.00000	286.00000	-.00574	-.01576	-110.01217	.01678	-35.50607	.11618	-18.69707
89.00000	288.00000	-.01545	-.00608	-158.52924	.01660	-35.59877	.11495	-18.78977
89.00000	290.00000	-.01382	.00882	147.44510	.01640	-35.70318	.11358	-18.89418
89.00000	292.00000	.00057	.01617	87.97645	.01618	-35.81958	.11207	-19.01058
89.00000	294.00000	.01466	.00626	23.13741	.01594	-35.94830	.11042	-19.13930
89.00000	296.00000	.01070	-.01147	-46.99300	.01569	-36.08970	.10863	-19.28069
89.00000	298.00000	-.00824	-.01302	-122.32949	.01541	-36.24420	.10672	-19.43520
89.00000	300.00000	-.01394	.00585	157.21978	.01511	-36.41229	.10467	-19.60329
89.00000	302.00000	.00463	.01406	71.75291	.01480	-36.59449	.10250	-19.78549
89.00000	304.00000	.01371	-.00462	-18.62606	.01447	-36.79142	.10020	-19.98242
89.00000	306.00000	-.00570	-.01292	-113.80710	.01412	-37.00375	.09778	-20.19475
89.00000	308.00000	-.01145	.00763	146.32608	.01375	-37.23226	.09524	-20.42326
89.00000	310.00000	.00995	.00893	41.89481	.01337	-37.47782	.09259	-20.66882
89.00000	312.00000	.00507	-.01194	-66.97362	.01297	-37.74143	.08982	-20.93243
89.00000	314.00000	-.01255	.00003	179.85364	.01255	-38.02423	.08694	-21.21522
89.00000	316.00000	.00560	.01076	62.51438	.01212	-38.32747	.08396	-21.51847
89.00000	318.00000	.00604	-.00999	-58.84876	.01168	-38.65269	.08088	-21.84369
89.00000	320.00000	-.01119	.00080	175.91272	.01122	-39.00253	.07768	-22.19353
89.00000	322.00000	.00733	.00785	46.95083	.01074	-39.37709	.07440	-22.56809
89.00000	324.00000	.00079	-.01023	-85.57719	.01026	-39.77964	.07103	-22.97064
89.00000	326.00000	-.00731	.00647	138.49046	.00976	-40.21291	.06758	-23.40391
89.00000	328.00000	.00925	-.00011	-.68098	.00925	-40.68012	.06404	-23.87112

BEST AVAILABLE COPY

TABLE A-2

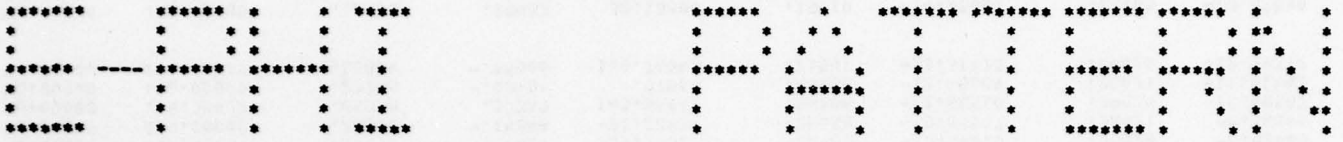
(Page 10 of 10)

89.00000	330.00000	-.00696	-.00526	-142.92169	.00872	-41.18513	.06042	-24.37613
89.00000	332.00000	.00254	.00779	71.94116	.00819	-41.73264	.05673	-24.92363
89.00000	334.00000	.00186	-.00742	-75.91481	.00765	-42.32833	.05297	-25.51933
89.00000	336.00000	-.00490	.00513	133.68977	.00710	-42.97932	.04915	-26.17032
89.00000	338.00000	.00618	-.00213	-19.06170	.00654	-43.69458	.04526	-26.88558
89.00000	340.00000	-.00593	-.00063	-173.98263	.00597	-44.48569	.04132	-27.67669
89.00000	342.00000	.00471	.00262	29.11531	.00539	-45.36792	.03733	-28.55892
89.00000	344.00000	-.00306	-.00371	-129.57684	.00481	-46.36154	.03329	-29.55254
89.00000	346.00000	.00143	.00397	70.13470	.00422	-47.49583	.02922	-30.68682
89.00000	348.00000	-.00010	-.00362	-91.55495	.00362	-48.81553	.02510	-32.00653
89.00000	350.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	352.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	354.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	356.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	358.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099
89.00000	360.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-583.19099

BEST AVAILABLE COPY

TABLE A-3

BOEING 747 AZIMUTH PLANE E-PHI AND E-THETA TABULATIONS
(Page 1 of 10)



ROTATED COORDINATES (THO = .00000 , PHO = .00000)

THETA	PHI	E-PHI		PHASE	UNNORMALIZED MAGNITUDE	UNNORMALIZED DB	NORMALIZED MAGNITUDE	NORMALIZED DB
90.00000	.00000	.00000	.00000	.00000	.00000	-600.00000	.00000	-598.92838
90.00000	2.00000	-.01079	-.03319	-108.01664	.03490	-29.14362	.03948	-28.07201
90.00000	4.00000	-.03135	-.06232	-116.70278	.06976	-23.12831	.07892	-22.05670
90.00000	6.00000	-.06881	-.07869	-131.16787	.10453	-19.61531	.11825	-18.54370
90.00000	8.00000	-.12218	-.06663	-151.39430	.13917	-17.12889	.15745	-16.05728
90.00000	10.00000	-.17346	-.00801	-177.35743	.17365	-15.20660	.19645	-14.13499
90.00000	12.00000	-.18180	.10088	150.97437	.20791	-13.64242	.23521	-12.57081
90.00000	14.00000	-.09699	.22159	113.63962	.24189	-12.32753	.27366	-11.25592
90.00000	16.00000	.09116	.26008	70.68391	.27560	-11.19446	.31179	-10.12285
90.00000	18.00000	.28614	.11654	22.15951	.30896	-10.20185	.34953	-9.13024
90.00000	20.00000	.29038	-.18057	-31.87444	.34195	-9.32083	.38685	-8.24922
90.00000	22.00000	-.00884	-.37440	-91.35211	.37451	-8.53080	.42368	-7.45919
90.00000	24.00000	-.37203	-.16408	-156.20104	.40660	-7.81656	.45999	-6.74495
90.00000	26.00000	-.30251	.31703	133.65772	.43820	-7.16656	.49574	-6.09495
90.00000	28.00000	.24651	.39929	58.30975	.46925	-6.57190	.53087	-5.50029
90.00000	30.00000	.46283	-.18844	-22.15321	.49972	-6.02550	.56533	-4.95389
90.00000	32.00000	-.16042	-.50470	-107.63313	.52959	-5.52127	.59912	-4.44966
90.00000	34.00000	-.53136	.17292	161.97412	.55879	-5.05500	.63216	-3.98339
90.00000	36.00000	.23157	.53973	66.77866	.58731	-4.62266	.66443	-3.55105
90.00000	38.00000	.51507	-.33582	-33.10351	.61488	-4.22421	.69562	-3.15260
90.00000	40.00000	-.47353	-.43314	-137.55065	.64174	-3.85275	.72601	-2.78114
90.00000	42.00000	-.26696	.61208	113.56446	.66776	-3.50757	.75544	-2.43596
90.00000	44.00000	.69275	.00453	.37438	.69277	-3.18823	.78373	-2.11662
90.00000	46.00000	-.32520	-.63871	-116.98283	.71673	-2.89292	.81084	-1.82131
90.00000	48.00000	-.38796	.62975	121.63571	.73966	-2.61938	.83678	-1.54777

BEST AVAILABLE COPY

TABLE A-3

(Page 2 of 10)

90.00000	50.00000	.76011	-.04812	-3.62206	.76163	-2.36510	.86164	-1.29349
90.00000	52.00000	-.52985	-.57614	-132.60357	.78274	-2.12763	.88552	-1.05602
90.00000	54.00000	-.06783	.79962	94.84836	.80249	-1.91117	.90787	-.83956
90.00000	56.00000	.61719	-.53850	-41.10484	.81909	-1.73337	.92664	-.66176
90.00000	58.00000	-.83501	.00433	179.70255	.83502	-1.56610	.94466	-.49449
90.00000	60.00000	.67437	.51635	37.44009	.84935	-1.41829	.96087	-.34668
90.00000	62.00000	-.26220	-.82063	-107.71902	.86150	-1.29489	.97462	-.22328
90.00000	64.00000	-.21668	.84378	104.40224	.87116	-1.19808	.98555	-.12647
90.00000	66.00000	.60985	-.63187	-46.01598	.87817	-1.12845	.99348	-.05684
90.00000	68.00000	-.83542	.28425	161.20950	.88246	-1.08613	.99833	-.01452
90.00000	70.00000	.87863	.09646	6.26486	.88391	-1.07184	.99997	-.00023
90.00000	72.00000	-.76882	-.43212	-150.66121	.88193	-1.09127	.99774	-.01966
90.00000	74.00000	.55557	.67691	50.62265	.87570	-1.15286	.99069	-.08125
90.00000	76.00000	-.29195	-.81581	-109.69030	.86648	-1.24488	.98025	-.17327
90.00000	78.00000	.02093	.85365	88.59521	.85390	-1.37184	.96603	-.30023
90.00000	80.00000	.22635	-.80653	-74.32365	.83769	-1.53836	.94768	-.46675
90.00000	82.00000	-.43025	.69523	121.75151	.81759	-1.74930	.92494	-.67769
90.00000	84.00000	.58046	-.54090	-42.97955	.79342	-2.00995	.89760	-.93834
90.00000	86.00000	-.67315	.36270	151.68376	.76465	-2.33079	.86505	-1.25918
90.00000	88.00000	.71048	-.17789	-14.05696	.73241	-2.70491	.82858	-1.63330
90.00000	90.00000	-.69547	.00671	179.44692	.69550	-3.15406	.78682	-2.08245
90.00000	92.00000	.65137	.13420	11.64136	.66505	-3.54287	.75238	-2.47126
90.00000	94.00000	-.57575	-.25187	-156.37259	.62843	-4.03485	.71095	-2.96324
90.00000	96.00000	.47906	.34122	35.46131	.58816	-4.61010	.66539	-3.53849
90.00000	98.00000	-.37214	-.40185	-132.80175	.54769	-5.22926	.61961	-4.15765
90.00000	100.00000	.26323	.43623	58.89242	.50950	-5.85712	.57640	-4.78551
90.00000	102.00000	-.14111	-.44934	-107.43432	.47098	-6.54002	.53282	-5.46841
90.00000	104.00000	.04508	.43646	84.10321	.43878	-7.15501	.49640	-6.08340
90.00000	106.00000	.04252	-.40398	-83.99154	.40622	-7.82486	.45956	-6.75325
90.00000	108.00000	-.11790	.35513	108.36526	.37419	-8.53811	.42333	-7.46650
90.00000	110.00000	.17808	-.29354	-58.75641	.34333	-9.28568	.38842	-8.21407
90.00000	112.00000	-.22091	.22321	134.70317	.31405	-10.06010	.35528	-8.98849
90.00000	114.00000	.24512	-.14848	-31.20558	.28658	-10.85507	.32421	-9.78346
90.00000	116.00000	-.25038	.07389	163.55811	.26106	-11.66518	.29534	-10.59357
90.00000	118.00000	.23748	-.00404	-.97560	.23752	-12.48604	.26871	-11.41443
90.00000	120.00000	-.20834	-.05666	-164.78643	.21591	-13.31473	.24426	-12.24312
90.00000	122.00000	.16605	.10432	32.13804	.19610	-14.15051	.22185	-13.07890
90.00000	124.00000	-.11481	-.13592	-130.18773	.17792	-14.99532	.20129	-13.92371
90.00000	126.00000	.05969	.14973	68.26466	.16119	-15.85330	.18235	-14.78169
90.00000	128.00000	-.00623	-.14561	-92.45001	.14574	-16.72853	.16487	-15.65692
90.00000	130.00000	-.04009	.12525	107.74975	.13151	-17.62088	.14878	-16.54927
90.00000	132.00000	.07452	-.09221	-51.05377	.11856	-18.52137	.13413	-17.44976
90.00000	134.00000	-.09374	.05161	151.16341	.10701	-19.41121	.12107	-18.33960
90.00000	136.00000	.09646	-.00963	-5.69881	.09693	-20.27040	.10966	-19.19879
90.00000	138.00000	-.08376	-.02743	-161.86672	.08814	-21.09681	.09971	-20.02520
90.00000	140.00000	.05914	.05408	42.44464	.08014	-21.92332	.09066	-20.85171

BEST AVAILABLE COPY

TABLE A-3

(Page 3 of 10)

90.00000	142.00000	-.02796	-.06673	-112.73677	.07235	-22.81069	.08186	-21.73908
90.00000	144.00000	-.00340	.06443	93.01843	.06452	-23.80588	.07299	-22.73427
90.00000	146.00000	.02886	-.04919	-59.59599	.05703	-24.87747	.06452	-23.80586
90.00000	148.00000	-.04391	.02562	149.73559	.05084	-25.87661	.05751	-24.80500
90.00000	150.00000	.04657	.00005	.05637	.04657	-26.63774	.05269	-25.56613
90.00000	152.00000	-.03789	-.02145	-150.48555	.04354	-27.22297	.04925	-26.15135
90.00000	154.00000	.02152	.03369	57.43219	.03998	-27.96273	.04523	-26.89112
90.00000	156.00000	-.00270	-.03465	-94.45195	.03475	-29.18080	.03931	-28.10919
90.00000	158.00000	-.01333	.02544	117.65165	.02872	-30.83650	.03249	-29.76489
90.00000	160.00000	.02274	-.01006	-23.87602	.02487	-32.08821	.02813	-31.01660
90.00000	162.00000	-.02411	-.00596	-166.11902	.02484	-32.09867	.02810	-31.02706
90.00000	164.00000	.01855	.01738	43.13260	.02542	-31.89637	.02876	-30.82476
90.00000	166.00000	-.00898	-.02092	-113.22202	.02277	-32.85323	.02576	-31.78162
90.00000	168.00000	-.00111	.01629	93.88784	.01633	-35.74070	.01847	-34.66909
90.00000	170.00000	.00884	-.00611	-34.84040	.01074	-39.37908	.01215	-38.30747
90.00000	172.00000	-.01274	-.00518	-157.86181	.01375	-37.23376	.01556	-36.16215
90.00000	174.00000	.01278	.01302	45.51828	.01825	-34.77680	.02064	-33.70519
90.00000	176.00000	-.00991	-.01447	-124.40744	.01754	-35.11793	.01985	-34.04632
90.00000	178.00000	.00532	.00931	60.25254	.01072	-39.39278	.01213	-38.32117
90.00000	180.00000	.00000	.00000	47.46084	.00000	-143.84576	.00000	-142.77415
90.00000	182.00000	-.00532	-.00931	-119.74751	.01072	-39.39272	.01213	-38.32111
90.00000	184.00000	.00991	.01447	55.59252	.01754	-35.11793	.01985	-34.04632
90.00000	186.00000	-.01278	-.01302	-134.48172	.01825	-34.77681	.02064	-33.70519
90.00000	188.00000	.01274	.00518	22.13805	.01375	-37.23378	.01556	-36.16217
90.00000	190.00000	-.00884	.00611	145.35922	.01074	-39.37909	.01215	-38.30748
90.00000	192.00000	.00111	-.01629	-86.11242	.01633	-35.74068	.01847	-34.66907
90.00000	194.00000	.00898	.02092	66.77793	.02277	-32.85322	.02576	-31.78161
90.00000	196.00000	-.01855	-.01738	-136.86758	.02542	-31.89637	.02876	-30.82476
90.00000	198.00000	.02411	.00596	13.88087	.02484	-32.09868	.02810	-31.02707
90.00000	200.00000	-.02274	.01006	156.12386	.02487	-32.08821	.02813	-31.01660
90.00000	202.00000	.01333	-.02544	-62.34863	.02872	-30.83649	.03249	-29.76488
90.00000	204.00000	.00270	.03465	85.54800	.03475	-29.18080	.03931	-28.10919
90.00000	206.00000	-.02152	-.03369	-122.56806	.03998	-27.96273	.04523	-26.89112
90.00000	208.00000	.03789	.02145	29.51428	.04354	-27.22297	.04925	-26.15136
90.00000	210.00000	-.04657	-.00005	-179.94378	.04657	-26.63774	.05269	-25.56613
90.00000	212.00000	.04391	-.02562	-30.26470	.05084	-25.87661	.05751	-24.80500
90.00000	214.00000	-.02886	.04919	120.40379	.05703	-24.87747	.06452	-23.80586
90.00000	216.00000	.00340	-.06443	-86.98165	.06452	-23.80588	.07299	-22.73427
90.00000	218.00000	.02797	.06673	67.26303	.07235	-22.81069	.08186	-21.73908
90.00000	220.00000	-.05914	-.05408	-137.55563	.08014	-21.92332	.09066	-20.85171
90.00000	222.00000	.08376	.02743	18.13308	.08814	-21.09681	.09971	-20.02520
90.00000	224.00000	-.09646	.00963	174.30093	.09693	-20.27040	.10966	-19.19879
90.00000	226.00000	.09374	-.05161	-28.83670	.10701	-19.41121	.12107	-18.33960
90.00000	228.00000	-.07452	.09221	128.94595	.11856	-18.52137	.13413	-17.44976
90.00000	230.00000	.04009	-.12525	-72.25037	.13151	-17.62088	.14878	-16.54927
90.00000	232.00000	.00623	.14561	87.54968	.14574	-16.72853	.16487	-15.68092
90.00000	234.00000	-.05969	-.14973	-111.73577	.16119	-15.85330	.18235	-14.78169
90.00000	236.00000	.11481	.13592	49.81213	.17792	-14.99532	.20129	-13.92371

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TABLE A-3

(Page 4 of 10)

90.00000	238.00000	-.16605	-.10432	-147.86218	.19610	-14.15051	.22185	-13.07890
90.00000	240.00000	.20834	.05666	15.21316	.21591	-13.31473	.24426	-12.24312
90.00000	242.00000	-.23748	.00404	179.02433	.23752	-12.48604	.26871	-11.41443
90.00000	244.00000	.25038	-.07389	-16.44210	.26106	-11.66518	.29534	-10.59357
90.00000	246.00000	-.24512	.14848	148.79407	.28658	-10.85507	.32421	-9.78346
90.00000	248.00000	.22091	-.22321	-45.29695	.31405	-10.06010	.35528	-8.98849
90.00000	250.00000	-.17808	.29354	121.24339	.34333	-9.28568	.38842	-8.21407
90.00000	252.00000	.11790	-.35513	-71.63506	.37419	-8.53812	.42333	-7.46651
90.00000	254.00000	-.04252	.40398	96.00836	.40622	-7.82486	.45955	-6.75325
90.00000	256.00000	-.04508	-.43646	-95.89700	.43878	-7.15501	.49640	-6.08340
90.00000	258.00000	.14111	.44934	72.56540	.47098	-6.54003	.53282	-5.46842
90.00000	260.00000	-.26332	-.43632	-121.11087	.50962	-5.85510	.57653	-4.78349
90.00000	262.00000	.37220	.40194	47.20025	.54780	-5.22755	.61973	-4.15594
90.00000	264.00000	-.47910	-.34131	-144.53352	.58824	-4.60888	.66548	-3.53727
90.00000	266.00000	.57577	.25195	23.63398	.62848	-4.03417	.71100	-2.96256
90.00000	268.00000	-.65137	-.13428	-168.35187	.66507	-3.54268	.75240	-2.47107
90.00000	270.00000	.69545	-.00664	-.54719	.69548	-3.15427	.78680	-2.08266
90.00000	272.00000	-.71045	.17783	165.94691	.73237	-2.70540	.82853	-1.63379
90.00000	274.00000	.67311	-.36265	-28.31425	.76459	-2.33142	.86499	-1.25981
90.00000	276.00000	-.58042	.54087	137.02027	.79336	-2.01057	.89754	-.93896
90.00000	278.00000	.43020	-.69520	-58.25033	.81754	-1.74979	.92489	-.67818
90.00000	280.00000	-.22630	.80651	105.67370	.83766	-1.53865	.94765	-.46704
90.00000	282.00000	-.02098	-.85364	-91.40777	.85390	-1.37190	.96602	-.30029
90.00000	284.00000	.29199	.81581	70.30701	.86649	-1.24474	.98027	-.17313
90.00000	286.00000	-.55560	-.67691	-129.37882	.87573	-1.15258	.99072	-.08097
90.00000	288.00000	.76884	.43214	29.33853	.88197	-1.09096	.99777	-.01935
90.00000	290.00000	-.87865	-.09647	-173.73443	.88393	-1.07161	1.00000	.00000
90.00000	292.00000	.83544	-.28423	-18.78903	.88246	-1.08606	.99834	-.01445
90.00000	294.00000	-.60986	.63185	133.98519	.87816	-1.12855	.99347	-.05694
90.00000	296.00000	.21668	-.84376	-75.59752	.87114	-1.19828	.98552	-.12667
90.00000	298.00000	.26220	.82061	72.28008	.86148	-1.29506	.97460	-.22345
90.00000	300.00000	-.67438	-.51633	-142.56127	.84934	-1.41832	.96087	-.34671
90.00000	302.00000	.83502	-.00435	-.29846	.83503	-1.56598	.94467	-.49437
90.00000	304.00000	-.61720	.53851	138.89508	.81910	-1.73322	.92666	-.66161
90.00000	306.00000	.06784	-.79962	-85.15090	.80250	-1.91113	.90787	-.83952
90.00000	308.00000	.52985	.57614	47.39674	.78273	-2.12774	.88551	-1.05613
90.00000	310.00000	-.76010	.04812	176.37722	.76162	-2.36520	.86163	-1.29359
90.00000	312.00000	.38796	-.62975	-58.36516	.73966	-2.61934	.83678	-1.54773
90.00000	314.00000	.32520	.63871	63.01712	.71674	-2.89282	.81085	-1.82121
90.00000	316.00000	-.69275	-.00453	-179.62519	.69277	-3.18824	.78373	-2.11663
90.00000	318.00000	.26695	-.61207	-66.43574	.66775	-3.50766	.75544	-2.43605
90.00000	320.00000	.47353	.43313	42.44867	.64175	-3.85273	.72601	-2.78112
90.00000	322.00000	-.51508	.33582	146.89653	.61488	-4.22414	.69562	-3.15253
90.00000	324.00000	-.23156	-.53973	-113.22100	.58731	-4.62271	.66442	-3.55110
90.00000	326.00000	.53136	-.17292	-18.02647	.55879	-5.05504	.63216	-3.98343
90.00000	328.00000	.16043	.50471	72.36669	.52959	-5.52120	.59913	-4.44959

TABLE A-3

(Page 5 of 10)

90.00000	330.00000	-.46283	.18843	157.84700	.49972	-6.02554	.56533	-4.95393
90.00000	332.00000	-.24651	-.39928	-121.69070	.46925	-6.57192	.53087	-5.50031
90.00000	334.00000	.30251	-.31703	-46.34220	.43820	-7.16650	.49574	-6.09489
90.00000	336.00000	.37203	.16407	23.79888	.40660	-7.81662	.45999	-6.74501
90.00000	338.00000	.00884	.37440	88.64750	.37451	-8.53076	.42368	-7.45915
90.00000	340.00000	-.29038	.18057	148.12580	.34195	-9.32085	.38685	-8.24924
90.00000	342.00000	-.28614	-.11653	-157.84097	.30896	-10.20185	.34953	-9.13024
90.00000	344.00000	-.09116	-.26009	-109.31579	.27560	-11.19444	.31179	-10.12283
90.00000	346.00000	.09699	-.22159	-66.36077	.24189	-12.32756	.27365	-11.25595
90.00000	348.00000	.18180	-.10088	-29.02534	.20791	-13.64239	.23521	-12.57078
90.00000	350.00000	.17346	.00800	2.64213	.17365	-15.20662	.19645	-14.13501
90.00000	352.00000	.12218	.06663	28.60610	.13917	-17.12887	.15745	-16.05726
90.00000	354.00000	.06881	.07869	48.83151	.10453	-19.61531	.11825	-18.54370
90.00000	356.00000	.03135	.06232	63.29793	.06976	-23.12834	.07892	-22.05673
90.00000	358.00000	.01079	.03319	71.98241	.03490	-29.14346	.03948	-28.07185
90.00000	360.00000	-.00000	-.00000	-116.56747	.00000	-122.70856	.00000	-121.63695

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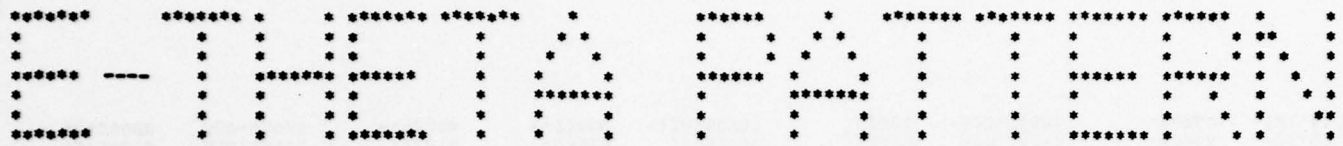
TABLE A-3

(Page 6 of 10)



ROTATED COORDINATES (THO = .00000 , PHO = .00000)

THETA	PHI	E-THETA		PHASE	UNNORMALIZED MAGNITUDE	UNNORMALIZED DB	NORMALIZED MAGNITUDE	NORMALIZED DB
90.00000	.00000	.00000	.00000	74.87990	.00000	-180.46112	.82509	-1.66994
90.00000	2.00000	.00000	.00000	71.98336	.00000	-180.49352	.82202	-1.70235
90.00000	4.00000	.00000	.00000	63.29721	.00000	-180.66896	.80558	-1.87778
90.00000	6.00000	.00000	.00000	48.83213	.00000	-180.87144	.78702	-2.08026
90.00000	8.00000	.00000	.00000	28.60570	.00000	-181.74170	.71199	-2.95053
90.00000	10.00000	.00000	.00000	2.64257	.00000	-181.35843	.74411	-2.56725
90.00000	12.00000	.00000	-.00000	-29.02563	.00000	-181.64354	.72008	-2.85236
90.00000	14.00000	.00000	-.00000	-66.36037	.00000	-182.63334	.64253	-3.84216
90.00000	16.00000	-.00000	-.00000	-109.31609	.00000	-181.66277	.71849	-2.87159
90.00000	18.00000	-.00000	-.00000	-157.84049	.00000	-183.74546	.56531	-4.95428
90.00000	20.00000	-.00000	.00000	148.12556	.00000	-183.07326	.61080	-4.28208
90.00000	22.00000	.00000	.00000	88.64789	.00000	-182.51603	.65126	-3.72485
90.00000	24.00000	.00000	.00000	23.79896	.00000	-182.05922	.68643	-3.26804
90.00000	26.00000	.00000	-.00000	-46.34228	.00000	-186.05323	.43341	-7.26205
90.00000	28.00000	-.00000	-.00000	-121.69024	.00000	-185.76758	.44790	-6.97640
90.00000	30.00000	-.00000	.00000	157.84679	.00000	-185.55735	.45887	-6.76618
90.00000	32.00000	.00000	.00000	72.36687	.00000	-185.41753	.46632	-6.62635
90.00000	34.00000	.00000	-.00000	-18.02588	.00000	-185.34512	.47022	-6.55394
90.00000	36.00000	-.00000	-.00000	-113.22134	.00000	-185.33743	.47064	-6.54626
90.00000	38.00000	-.00000	.00000	146.89648	.00000	-185.39601	.46748	-6.60483
90.00000	40.00000	.00000	.00000	42.44934	.00000	-185.51567	.46108	-6.72450
90.00000	42.00000	.00000	-.00000	-66.43554	.00000	-185.69771	.45152	-6.90654
90.00000	44.00000	-.00000	-.00000	-179.62562	.00000	-195.11718	.15265	-16.32600
90.00000	46.00000	.00000	.00000	63.01716	.00000	-195.42838	.14728	-16.63720
90.00000	48.00000	.00000	-.00000	-58.36429	.00000	-195.80525	.14103	-17.01407

TABLE A-3

(Page 7 of 10)

90.00000	50.00000	-.00000	.00000	176.37794	.00000	-196.24871	.13401	-17.45753
90.00000	52.00000	.00000	.00000	47.39643	.00000	-196.76026	.12634	-17.96908
90.00000	54.00000	.00000	-.00000	-85.15164	.00000	-197.34874	.11807	-18.55756
90.00000	56.00000	-.00000	.00000	138.89516	.00000	-198.03722	.10907	-19.24604
90.00000	58.00000	.00000	-.00000	-.29745	.00000	-198.80403	.09985	-20.01285
90.00000	60.00000	-.00000	-.00000	-142.55991	.00000	-199.66581	.09042	-20.87463
90.00000	62.00000	.00000	.00000	72.28097	.00000	-200.63684	.08086	-21.84566
90.00000	64.00000	.00000	-.00000	-75.59776	.00000	-201.73072	.07129	-22.93955
90.00000	66.00000	-.00000	.00000	133.98402	.00000	-202.96225	.06187	-24.17107
90.00000	68.00000	.00000	-.00000	-18.79050	.00000	-204.34945	.05273	-25.55827
90.00000	70.00000	-.00000	-.00000	-173.73514	.00000	-205.91614	.04403	-27.12497
90.00000	72.00000	.00000	.00000	29.33879	.00000	-207.69832	.03586	-28.90715
90.00000	74.00000	-.00000	-.00000	-129.37735	.00000	-209.74569	.02833	-30.95451
90.00000	76.00000	.00000	.00000	70.30970	.00000	-212.10426	.02159	-33.31308
90.00000	78.00000	-.00000	-.00000	-91.40478	.00000	-214.86306	.01572	-36.07189
90.00000	80.00000	-.00000	.00000	105.67635	.00000	-218.15798	.01076	-39.36680
90.00000	82.00000	.00000	-.00000	-58.24849	.00000	-222.21359	.00674	-43.42241
90.00000	84.00000	-.00000	.00000	137.02045	.00000	-227.44725	.00369	-48.65608
90.00000	86.00000	.00000	-.00000	-28.31624	.00000	-234.79457	.00158	-56.00339
90.00000	88.00000	-.00000	.00000	165.94304	.00000	-247.20187	.00038	-68.41070
90.00000	90.00000	.00000	-.00000	-.55308	.00000	-315.10555	.00000	-136.31437
90.00000	92.00000	.00000	.00000	11.64136	.00000	-316.61406	.00000	-137.82289
90.00000	94.00000	-.00000	-.00000	-156.37259	.00000	-318.26588	.00000	-139.47471
90.00000	96.00000	.00000	.00000	35.46131	.00000	-318.84114	.00000	-140.04996
90.00000	98.00000	-.00000	-.00000	-132.80175	.00000	-320.79923	.00000	-142.00805
90.00000	100.00000	.00000	.00000	58.89242	.00000	-312.90772	.00000	-134.11654
90.00000	102.00000	-.00000	-.00000	-107.46907	.00000	-319.60436	.00000	-140.81318
90.00000	104.00000	.00000	.00000	84.06657	.00000	-316.70132	.00000	-137.91014
90.00000	106.00000	.00000	-.00000	-84.07186	.00000	-320.89509	.00000	-142.10392
90.00000	108.00000	-.00000	.00000	108.35052	.00000	-316.74939	.00000	-137.95822
90.00000	110.00000	.00000	-.00000	-58.84712	.00000	-328.39222	.00000	-149.60104
90.00000	112.00000	-.00000	.00000	134.68517	.00000	-319.61924	.00000	-140.82807
90.00000	114.00000	.00000	-.00000	-31.19622	.00000	-319.07166	.00000	-140.28049
90.00000	116.00000	.00000	-.00000	-59.26574	.00000	-374.92962	.00000	-196.13844
90.00000	118.00000	.00000	-.00000	-.00378	.00000	-337.63924	.00000	-158.84807
90.00000	120.00000	.00000	.00000	15.21356	.00000	-326.38592	.00000	-147.59474
90.00000	122.00000	-.00000	-.00000	-147.99756	.00000	-339.28799	.00000	-160.49681
90.00000	124.00000	-.00000	-.00000	-130.17104	.00000	-330.52589	.00000	-151.73471
90.00000	126.00000	-.00000	-.00000	-111.73533	.00000	-325.40267	.00000	-146.61149
90.00000	128.00000	.00000	.00000	87.92459	.00000	-335.83830	.00000	-157.04712
90.00000	130.00000	-.00000	.00000	107.74975	.00000	-330.69207	.00000	-151.90089
90.00000	132.00000	-.00000	.00000	153.81189	.00000	-365.23400	.00000	-186.44283
90.00000	134.00000	-.00000	.00000	151.16341	.00000	-332.48241	.00000	-153.69123
90.00000	136.00000	.00000	-.00000	-5.69881	.00000	-333.34159	.00000	-154.55041
90.00000	138.00000	.00000	.00000	17.45216	.00000	-330.68928	.00000	-151.89810
90.00000	140.00000	.00000	.00000	42.65212	.00000	-328.87687	.00000	-150.08570

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TABLE A-3

(Page 8 of 10)

90.00000	142.00000	.00000	.00000	70.14990	.00000	-342.55923	.00000	-163.76805
90.00000	144.00000	.00000	.00000	8.65616	.00000	-354.75300	.00000	-175.96182
90.00000	146.00000	.00000	-.00000	-61.02225	.00000	-336.25262	.00000	-157.46145
90.00000	148.00000	.00000	-.00000	-32.65296	.00000	-343.62529	.00000	-164.83411
90.00000	150.00000	.00000	.00000	12.24125	.00000	-346.00447	.00000	-167.21329
90.00000	152.00000	-.00000	-.00000	-140.23501	.00000	-340.95004	.00000	-162.15886
90.00000	154.00000	-.00000	-.00000	-122.11718	.00000	-337.80627	.00000	-159.01509
90.00000	156.00000	.00000	.00000	85.54805	.00000	-348.27260	.00000	-169.48142
90.00000	158.00000	.00000	-.00000	-18.29368	.00000	-356.92015	.00000	-178.12898
90.00000	160.00000	.00000	-.00000	-23.87602	.00000	-357.20061	.00000	-178.40943
90.00000	162.00000	-.00000	-.00000	-154.79794	.00000	-342.82556	.00000	-164.03438
90.00000	164.00000	.00000	.00000	49.60384	.00000	-341.57635	.00000	-162.78517
90.00000	166.00000	.00000	.00000	86.57227	.00000	-348.67464	.00000	-169.88346
90.00000	168.00000	-.00000	.00000	90.72571	.00000	-346.94230	.00000	-168.15112
90.00000	170.00000	-.00000	.00000	125.31465	.00000	-362.12168	.00000	-183.33050
90.00000	172.00000	.00000	-.00000	-72.77405	.00000	-343.20579	.00000	-164.41461
90.00000	174.00000	-.00000	-.00000	-138.09145	.00000	-349.58844	.00000	-170.79727
90.00000	176.00000	-.00000	-.00000	-141.50353	.00000	-348.18567	.00000	-169.39449
90.00000	178.00000	.00000	.00000	10.01855	.00000	-338.89182	.00000	-160.10065
90.00000	180.00000	-.00000	.00000	141.34939	.00000	-339.22403	.00000	-160.43286
90.00000	182.00000	.00000	.00000	32.38114	.00000	-343.35919	.00000	-164.56801
90.00000	184.00000	-.00000	-.00000	-153.00163	.00000	-342.87661	.00000	-164.08544
90.00000	186.00000	.00000	.00000	53.19407	.00000	-332.99412	.00000	-154.20294
90.00000	188.00000	.00000	-.00000	-57.04407	.00000	-343.08200	.00000	-164.29082
90.00000	190.00000	-.00000	.00000	137.51924	.00000	-350.28171	.00000	-171.49053
90.00000	192.00000	.00000	.00000	75.75253	.00000	-337.36298	.00000	-158.57180
90.00000	194.00000	-.00000	-.00000	-117.47942	.00000	-339.01402	.00000	-160.22284
90.00000	196.00000	.00000	.00000	47.42601	.00000	-340.94571	.00000	-162.15454
90.00000	198.00000	-.00000	-.00000	-163.67918	.00000	-329.54940	.00000	-150.75822
90.00000	200.00000	.00000	.00000	28.90486	.00000	-357.94447	.00000	-179.15329
90.00000	202.00000	.00000	-.00000	-44.16182	.00000	-345.88000	.00000	-167.08883
90.00000	204.00000	-.00000	-.00000	-94.45200	.00000	-323.92292	.00000	-145.13174
90.00000	206.00000	.00000	.00000	56.61523	.00000	-330.93010	.00000	-152.13892
90.00000	208.00000	-.00000	-.00000	-150.48571	.00000	-321.45400	.00000	-142.66282
90.00000	210.00000	.00000	.00000	2.17839	.00000	-329.54831	.00000	-150.75713
90.00000	212.00000	-.00000	.00000	149.94432	.00000	-322.46928	.00000	-143.67810
90.00000	214.00000	.00000	-.00000	-59.59621	.00000	-324.88441	.00000	-146.09323
90.00000	216.00000	-.00000	.00000	93.01835	.00000	-318.81527	.00000	-140.02409
90.00000	218.00000	-.00000	-.00000	-113.26420	.00000	-327.79511	.00000	-149.00393
90.00000	220.00000	.00000	.00000	42.95458	.00000	-328.73312	.00000	-149.94194
90.00000	222.00000	-.00000	-.00000	-94.86126	.00000	-364.94656	.00000	-186.15538
90.00000	224.00000	.00000	-.00000	-5.69907	.00000	-320.27734	.00000	-141.48616
90.00000	226.00000	-.00000	.00000	151.23311	.00000	-321.63108	.00000	-142.83990
90.00000	228.00000	-.00000	.00000	130.14181	.00000	-337.21097	.00000	-158.41980
90.00000	230.00000	-.00000	.00000	107.00308	.00000	-327.21688	.00000	-148.42571
90.00000	232.00000	-.00000	-.00000	-93.37992	.00000	-329.75333	.00000	-150.96215
90.00000	234.00000	-.00000	-.00000	-111.46951	.00000	-322.96466	.00000	-144.17348
90.00000	236.00000	.00000	.00000	49.79359	.00000	-320.15127	.00000	-141.36009

TABLE A-3

(Page 9 of 10)

90.00000	238.00000	-.00000	-.00000	-148.03667	.00000	-322.39320	.00000	-143.60202
90.00000	240.00000	-.00000	-.00000	-164.78684	.00000	-318.42712	.00000	-139.63595
90.00000	242.00000	-.00000	.00000	178.88625	.00000	-316.76456	.00000	-137.97339
90.00000	244.00000	-.00000	.00000	163.56682	.00000	-311.67358	.00000	-132.88241
90.00000	246.00000	.00000	-.00000	-31.20107	.00000	-316.88581	.00000	-138.09463
90.00000	248.00000	.00000	-.00000	-45.28663	.00000	-307.93233	.00000	-129.14116
90.00000	250.00000	-.00000	.00000	121.25471	.00000	-322.35503	.00000	-143.56385
90.00000	252.00000	.00000	-.00000	-71.59822	.00000	-310.72583	.00000	-131.93465
90.00000	254.00000	.00000	-.00000	-83.99492	.00000	-310.01465	.00000	-131.22348
90.00000	256.00000	.00000	.00000	84.09173	.00000	-322.72404	.00000	-143.93286
90.00000	258.00000	.00000	.00000	72.59274	.00000	-313.59601	.00000	-134.80483
90.00000	260.00000	.00000	.00000	58.88980	.00000	-312.37959	.00000	-133.58841
90.00000	262.00000	.00000	.00000	47.21349	.00000	-336.35026	.00000	-157.55908
90.00000	264.00000	.00000	.00000	35.46566	.00000	-309.72145	.00000	-130.93028
90.00000	266.00000	-.00000	-.00000	-156.36670	.00000	-308.93215	.00000	-130.14098
90.00000	268.00000	.00000	.00000	11.63815	.00000	-329.81518	.00000	-151.02401
90.00000	270.00000	-.00000	.00000	179.45911	.00000	-303.46351	.00000	-124.67233
90.00000	272.00000	-.00000	.00000	165.94268	.00000	-246.93246	.00039	-68.14129
90.00000	274.00000	.00000	-.00000	-28.31638	.00000	-234.54052	.00163	-55.74934
90.00000	276.00000	-.00000	.00000	137.02016	.00000	-227.21961	.00379	-48.42844
90.00000	278.00000	.00000	-.00000	-58.24883	.00000	-222.02317	.00689	-43.23200
90.00000	280.00000	-.00000	.00000	105.67621	.00000	-218.01558	.01093	-39.22440
90.00000	282.00000	-.00000	-.00000	-91.40499	.00000	-214.77960	.01587	-35.98842
90.00000	284.00000	.00000	.00000	70.30935	.00000	-212.09078	.02163	-33.29960
90.00000	286.00000	-.00000	-.00000	-129.37748	.00000	-209.81347	.02811	-31.02229
90.00000	288.00000	.00000	.00000	29.33860	.00000	-207.85878	.03521	-29.06761
90.00000	290.00000	-.00000	-.00000	-173.73548	.00000	-206.18098	.04271	-27.38980
90.00000	292.00000	.00000	-.00000	-18.79065	.00000	-204.73073	.05047	-25.93955
90.00000	294.00000	-.00000	.00000	133.98380	.00000	-203.47224	.05834	-24.68106
90.00000	296.00000	.00000	-.00000	-75.59800	.00000	-202.38211	.06614	-23.59093
90.00000	298.00000	.00000	.00000	72.28067	.00000	-201.44273	.07369	-22.65156
90.00000	300.00000	-.00000	-.00000	-142.56010	.00000	-200.63979	.08083	-21.84861
90.00000	302.00000	.00000	-.00000	-.29767	.00000	-199.96021	.08741	-21.16903
90.00000	304.00000	-.00000	.00000	138.89486	.00000	-199.39032	.09333	-20.59914
90.00000	306.00000	.00000	-.00000	-85.15180	.00000	-198.91417	.09859	-20.12299
90.00000	308.00000	.00000	.00000	47.39621	.00000	-198.55420	.10277	-19.76303
90.00000	310.00000	-.00000	.00000	176.37766	.00000	-198.28822	.10596	-19.49704
90.00000	312.00000	.00000	-.00000	-58.36445	.00000	-198.10836	.10818	-19.31719
90.00000	314.00000	.00000	.00000	63.01700	.00000	-198.01428	.10936	-19.22311
90.00000	316.00000	-.00000	-.00000	-179.62584	.00000	-198.00633	.10946	-19.21515
90.00000	318.00000	.00000	-.00000	-66.43567	.00000	-178.80568	.99833	-.01450
90.00000	320.00000	.00000	.00000	42.44923	.00000	-178.97251	.97934	-.18133
90.00000	322.00000	-.00000	.00000	146.89632	.00000	-179.22735	.95102	-.43617
90.00000	324.00000	-.00000	-.00000	-113.22139	.00000	-179.57125	.91411	-.78007
90.00000	326.00000	.00000	-.00000	-18.02604	.00000	-180.01206	.86887	-1.22089
90.00000	328.00000	.00000	.00000	72.36670	.00000	-180.55152	.81655	-1.76035

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TABLE A-3

(Page 10 of 10)

90.00000	330.00000	-.00000	.00000	157.84663	.00000	-181.19614	.75814	-2.40496
90.00000	332.00000	-.00000	-.00000	-121.69030	.00000	-181.95358	.69483	-3.16240
90.00000	334.00000	.00000	-.00000	-46.34238	.00000	-182.83457	.62781	-4.04340
90.00000	336.00000	.00000	.00000	23.79879	.00000	-180.42430	.82860	-1.63313
90.00000	338.00000	.00000	.00000	88.64778	.00000	-181.59588	.72404	-2.80470
90.00000	340.00000	-.00000	.00000	148.12545	.00000	-182.94358	.61998	-4.15240
90.00000	342.00000	-.00000	-.00000	-157.84060	.00000	-184.49717	.51844	-5.70599
90.00000	344.00000	-.00000	-.00000	-109.31614	.00000	-178.79118	1.00000	.00000
90.00000	346.00000	.00000	-.00000	-66.36043	.00000	-180.89500	.78489	-2.10383
90.00000	348.00000	.00000	-.00000	-29.02569	.00000	-181.47609	.73410	-2.68492
90.00000	350.00000	.00000	.00000	2.64251	.00000	-179.74761	.89573	-.95643
90.00000	352.00000	.00000	.00000	28.60565	.00000	-182.17085	.67767	-3.37967
90.00000	354.00000	.00000	.00000	48.83208	.00000	-179.84711	.88553	-1.05593
90.00000	356.00000	.00000	.00000	63.29721	.00000	-180.52141	.81939	-1.73023
90.00000	358.00000	.00000	.00000	71.98336	.00000	-180.07064	.86303	-1.27946
90.00000	360.00000	.00000	.00000	74.87990	.00000	-180.46112	.82509	-1.66994

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APPENDIX B

SYNTHESIZED AND MEASURED ANTENNA PATTERNS FOR ATCRBS ANTENNAS

In the case of the Boeing 747, Boeing 727 and Cessna 150 aircraft, measured data were provided by Lincoln Laboratories in the form of gain values expressed in dB. These have been compared statistically with the outputs of the model, which in this case are also expressed as gain in dB.

For the F-4 aircraft, measured data were provided by McDonnell-Douglas in the form of unitless gain values. A comparison with model outputs that are also unitless would not have the same meaning as dB comparisons. Therefore, in these cases, and in the cases where measured data were not available, no statistical comparison is provided.

Where given, the statistical information indicates the mutual error between the model's synthesized pattern and the measured pattern. The mean error (μ) and the standard deviation of the error distribution (σ) are relative values derived from the absolute difference, in decibels, between corresponding data points on the two patterns.

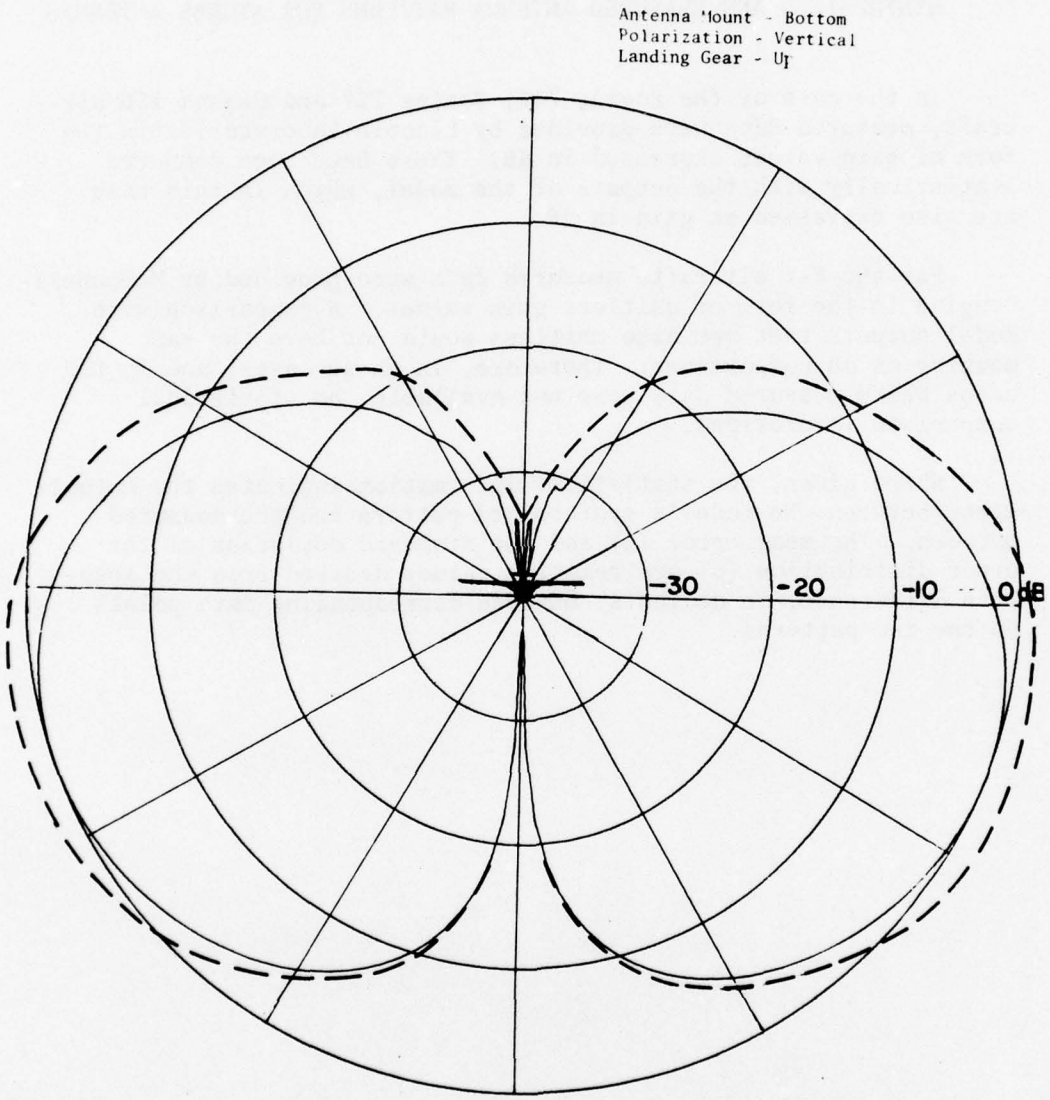

Figure B-1. Boeing 747 roll plane (E-PHI).

TABLE B-1

BOEING 747 ROLL PLANE

Card 1

2	4	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

156.	132.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	0.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WM	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	T
Additional Write out desired (T or F)	Pattern plotted by pen plotter (T or F)	*Is* flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

90	90	90	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6 - 10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

0.	0.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	PHC (phi rotation)	

Card 7 (for first wing)

4	4	180.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

1	150.	132.	-312.
2	150.	1200.	624.
3	150.	1200.	792.
4	150.	132.	288.
	X	Y	Z
	Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Col. 21-30 (F.P.)

Card 9

4.	3	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

For Additional Wings

Card 7 4 4 180.
Card 8 1. 150. -132. -312. 2. 150. -1200. 624. 3. 150. -1200. 792. 4. 150. -132. 288.

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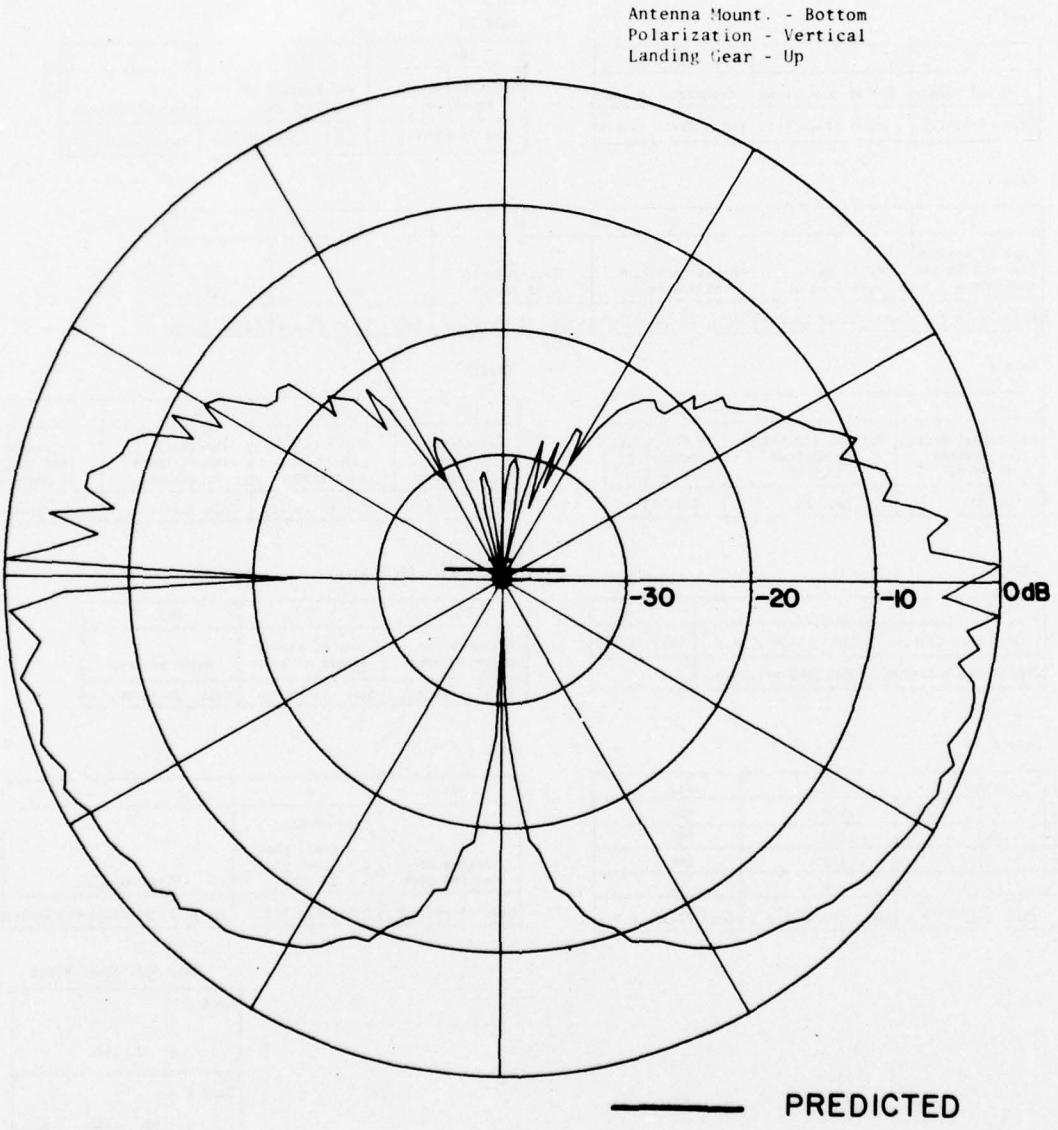

Figure B-2. Boeing 747 roll plane (Z - 768"; E-PHI).

TABLE B-2

BOEING 747 ROLL PLANE (Z=768)

Card 1

2	4	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

156.	132.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of Sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	768.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WM	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	T
Additional Write out desired (T or F)	Pattern plotted by pen plotter (T or F)	Is flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

90	90	90	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6-10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

0.	0.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	*PHC (phi rotation)*	

Card 7 (for first wing)

4	4	180.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

1	150.	132.	-312
2	150.	1200.	624.
3	150.	1200.	792.
4	150.	132.	288.
	X	Y	Z
	Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Col. 21-30 (F.P.)

Card 9

4.	3	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

For Additional Wings

Card 7

4 4 180.

Card 8

1. 150. -132. -312
2. 150. -1200 624.
3. 150. -1200 792.
4. 150. -132. 288.

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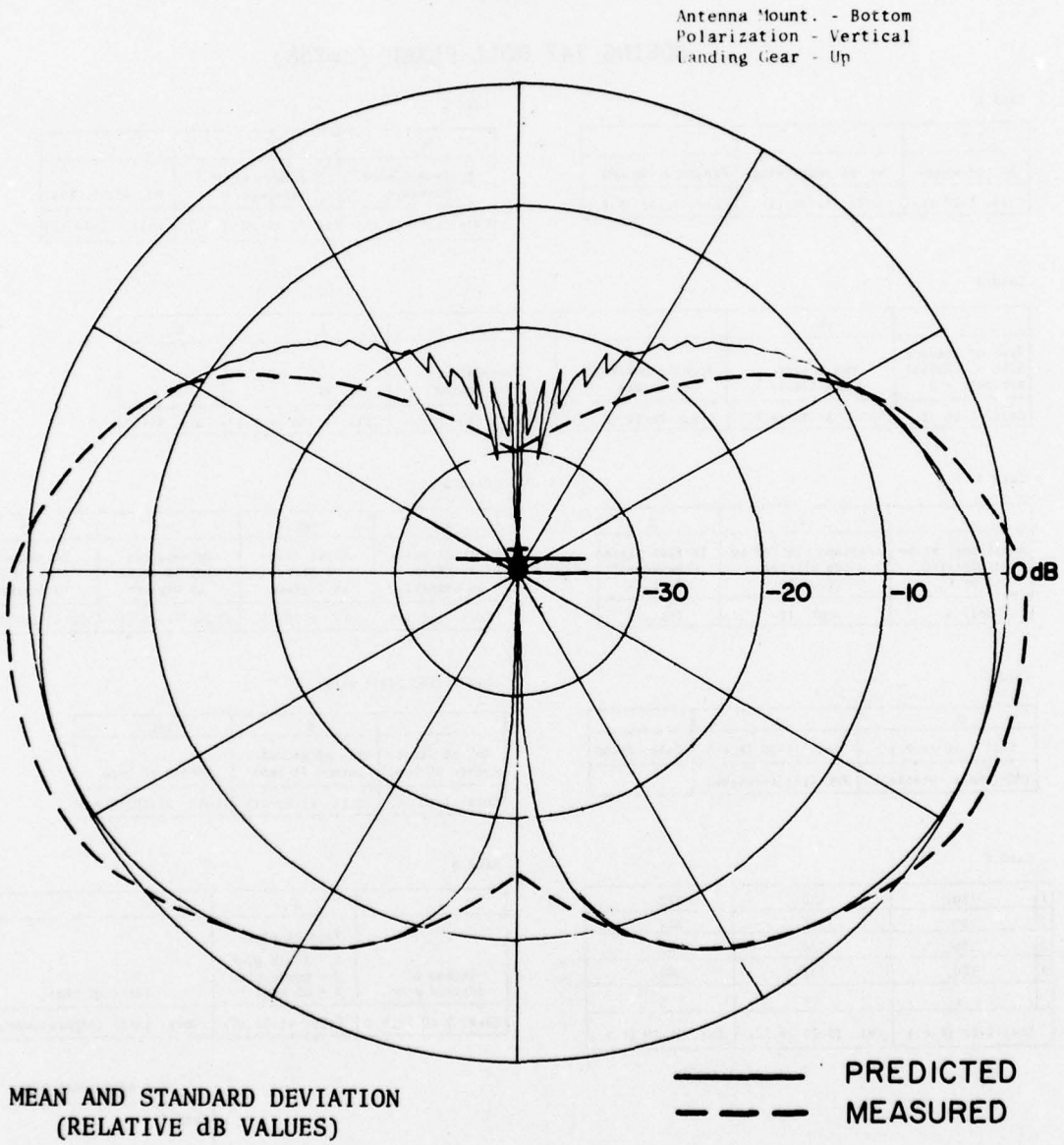

MEAN AND STANDARD DEVIATION
(RELATIVE dB VALUES)

μ = 2.0 dB
σ = 1.54 dB

Figure B-3. Boeing 747 roll plane (θ = 30°; E-PHI).

TABLE B-3

BOEING 747 ROLL PLANE (θ=30°)

Card 1

2	4	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

156.	132.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of Sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	0.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WM	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	T
Additional Write out desired (T or F)	Pattern plotted by pen plotter (T or F)	Is flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

30	30	90	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6-10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

0.	0.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	PHC (phi rotation)	

Card 7 (for first wing)

4	4	180.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

1	150.	132.	-312.
2	150.	1200.	624.
3	150.	1200.	792.
4	150.	132.	288.
	X	Y	Z
	Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Col. 21-30 (F.P.)

Card 9

4.	3	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

For Additional Wings

Card 7			
	4	4	180.
Card 8			
	1. 150.	-132.	-312.
	2. 150.	-1200.	624.
	3. 150.	-1200.	792.
	4. 150.	-132.	288.

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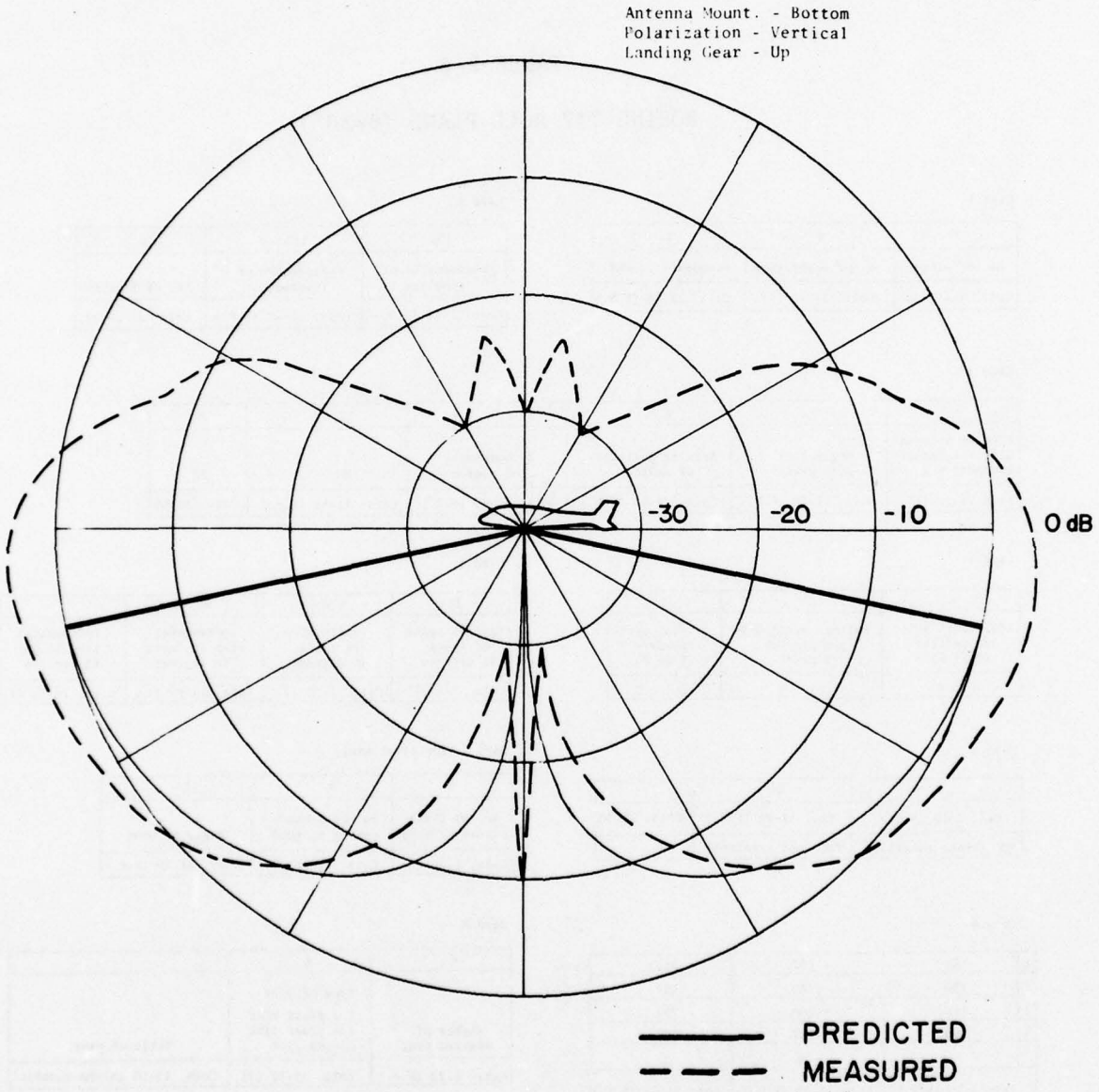

MEAN AND STANDARD DEVIATION
(RELATIVE dB VALUES)

μ = 4.4 dB
σ = 2.2 dB

Figure B-4. Boeing 747 elevation plane (E-PHI).

TABLE B-4

BOEING 747 ELEVATION PLANE

Card 1

2	4	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

156.	132.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of Sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	0.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WM	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	T
Additional Write out desired (T or F)	Pattern plotted by pen plotter (T or F)	Is flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

89	89	89	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6-10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

90.	90.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	PHC (phi rotation)	

Card 7 (for first wing)

4	4	180.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

	X	Y	Z
1	150.	132.	-312.
2	150.	1200.	624.
3	150.	1200.	792.
4	150.	132.	288.
	Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Col. 21-30 (F.P.)

Card 9

4.	3	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

For Additional Wings

Card 7			
	4	4	180.
Card 8			
1.	150.	-132.	-312.
2.	150.	-1200.	624.
3.	150.	-1200.	792.
4.	150.	-132.	288.

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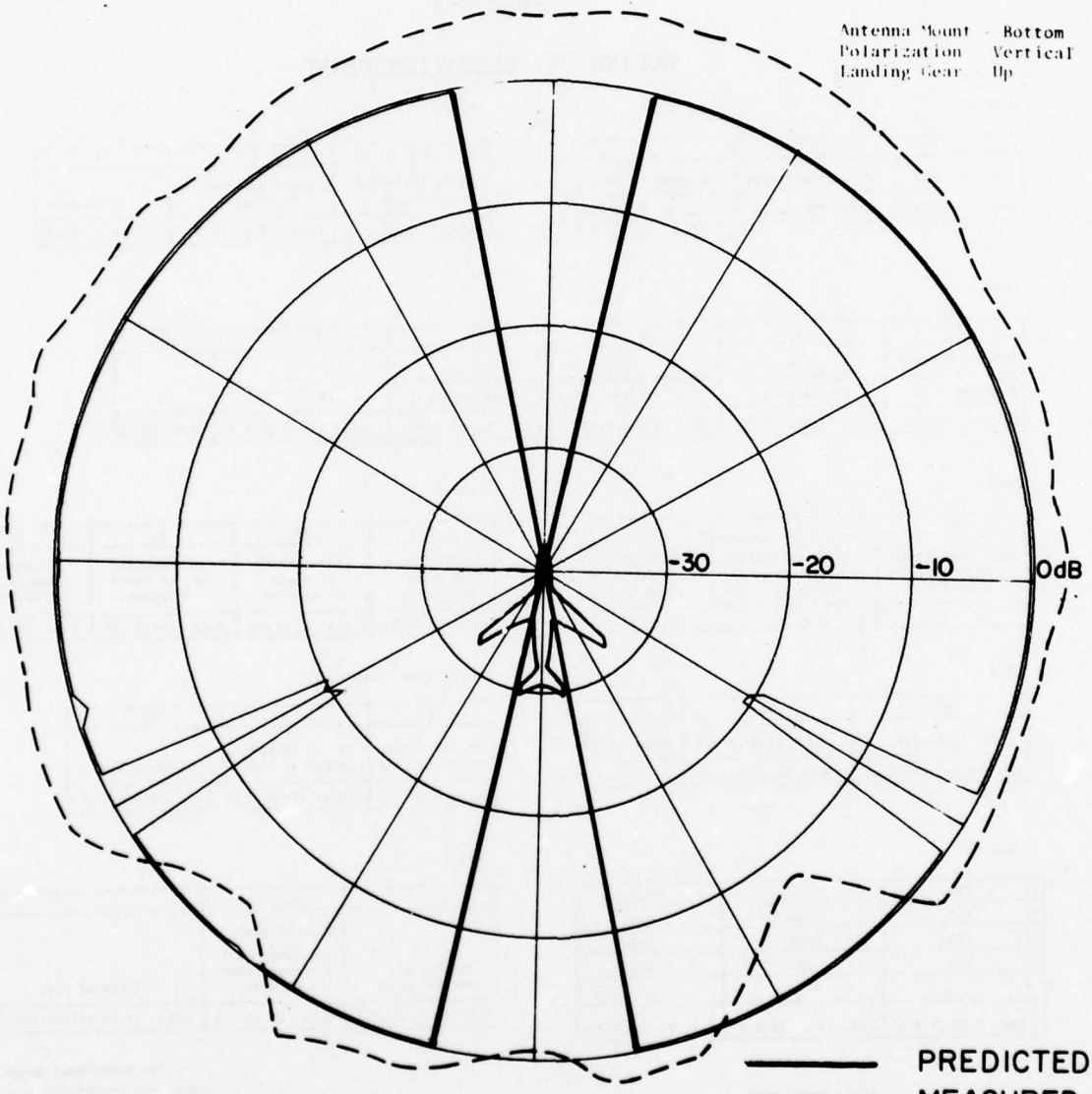

MEAN AND STANDARD DEVIATION
(RELATIVE dB VALUES)

μ = 5.3 dB
σ = 2.2 dB

Figure B-5. Boeing 747 azimuth plane (E-THETA).

TABLE B-5

BOEING 747 AZIMUTH PLANE

Card 1

2	4	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

156.	132.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of Sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	0.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WM	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	T
Additional write out desired (T or F)	Pattern plotted by pen plotter (T or F)	Is flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

90	90	90	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6-10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

90.	0.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	PHC (phi rotation)	

Card 7 (for first wing)

4	4	180.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

	X	Y	Z
1	150.	132.	-312.
2	150.	1200.	624.
3	150.	1200.	792.
4	150.	132.	288.
	Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Col. 21-30 (F.P.)

Card 9

4.	3	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

For Additional Wings

Card 7			
	4	4	180.
Card 8			
1.	150.	-132.	-312.
2.	150.	-1200.	624.
3.	150.	-1200.	792.
4.	150.	-132.	288.

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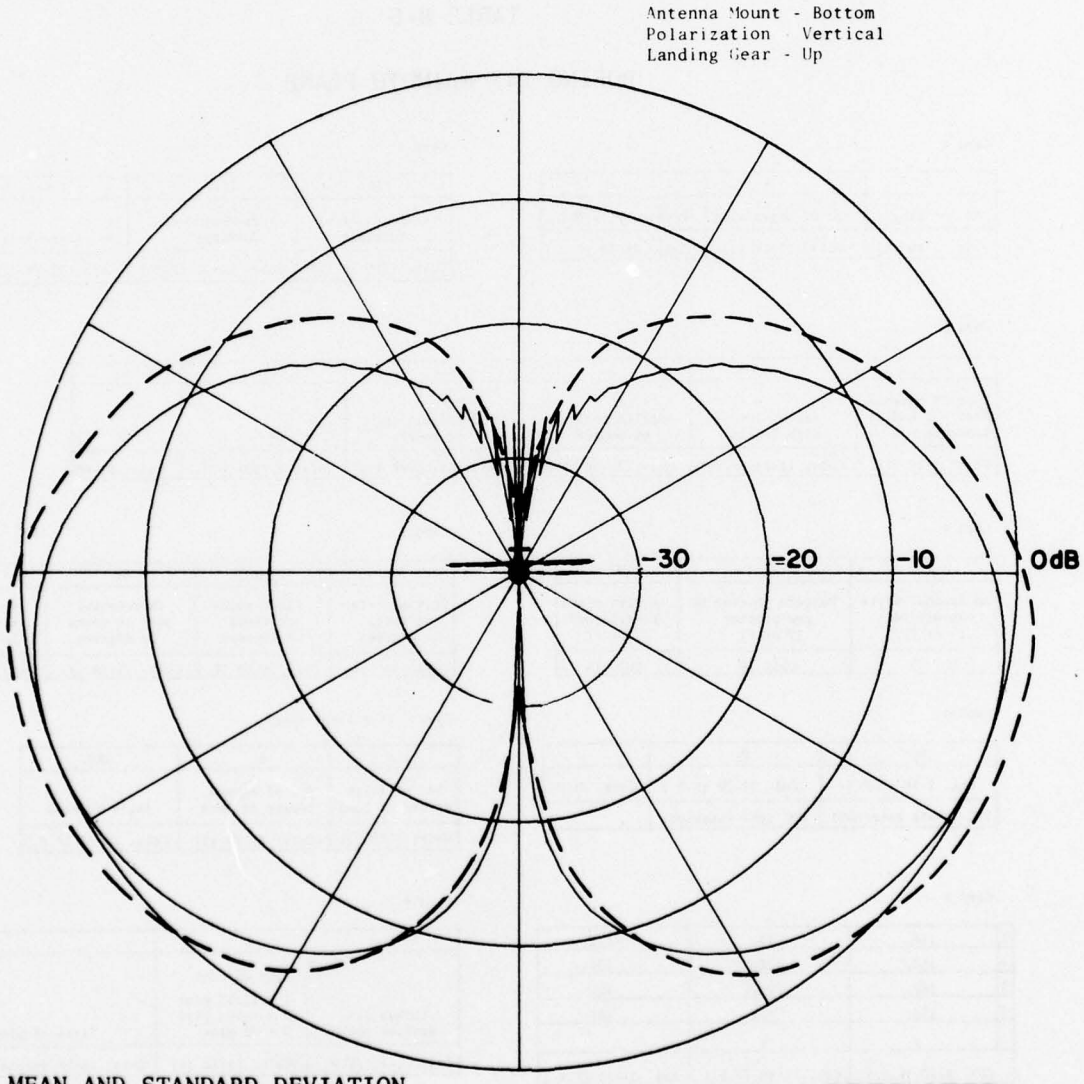

Figure B-6. Boeing 727 roll plane (E-PHI).

TABLE B-6

BOEING 727 ROLL PLANE

Card 1

2	4	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

90.	84.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of Sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	0.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WM	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	T
Additional Write out desired (T or F)	Pattern plotted by pen plotter (T or F)	Is flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

90	90	90	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6-10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

0.	0.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	PHC (phi rotation)	

Card 7 (for first wing)

4	4	180.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

1	72.	84.	264.
2	72.	600.	672.
3	72.	600.	768.
4	72.	84.	588.
	X	Y	Z
	Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Col. 21-30 (F.P.)

Card 9

4.	3	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

For Additional Wings

Card 7			
	4	4	180.
Card 8			
1.	72.	-84.	264.
2.	72.	-600.	672.
3.	72.	-600.	768.
4.	72.	-84.	588.

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Appendix B

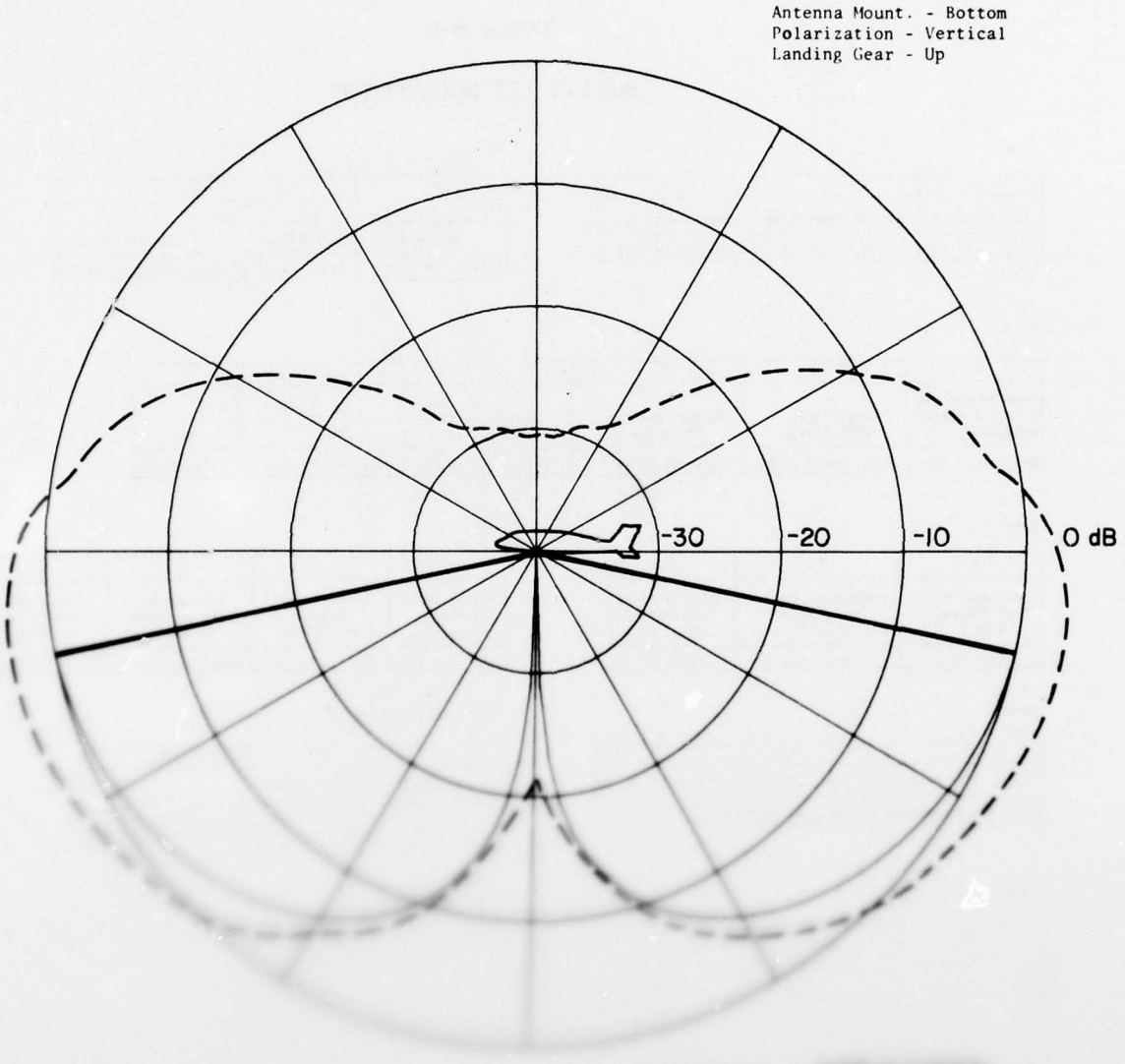
Antenna Mount. - Bottom
Polarization - Vertical
Landing Gear - Up
-30
-20
-10
0 dB

TABLE B-7

BOEING 727 ELEVATION PLANE

Card 1

2	4	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

90.	84.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of Sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	0.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WM	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	T
Additional Write out desired (T or F)	Pattern plotted by pen plotter (T or F)	Is flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

89	89	89	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6-10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

90.	90.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	PHC (phi rotation)	

Card 7 (for first wing)

4	4	180.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

1	72.	84.	264.
2	72.	600.	672.
3	72.	600.	768.
4	72.	84.	588.
	4	3	4
	Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)

Card 9

4.	3	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

For Additional Wings

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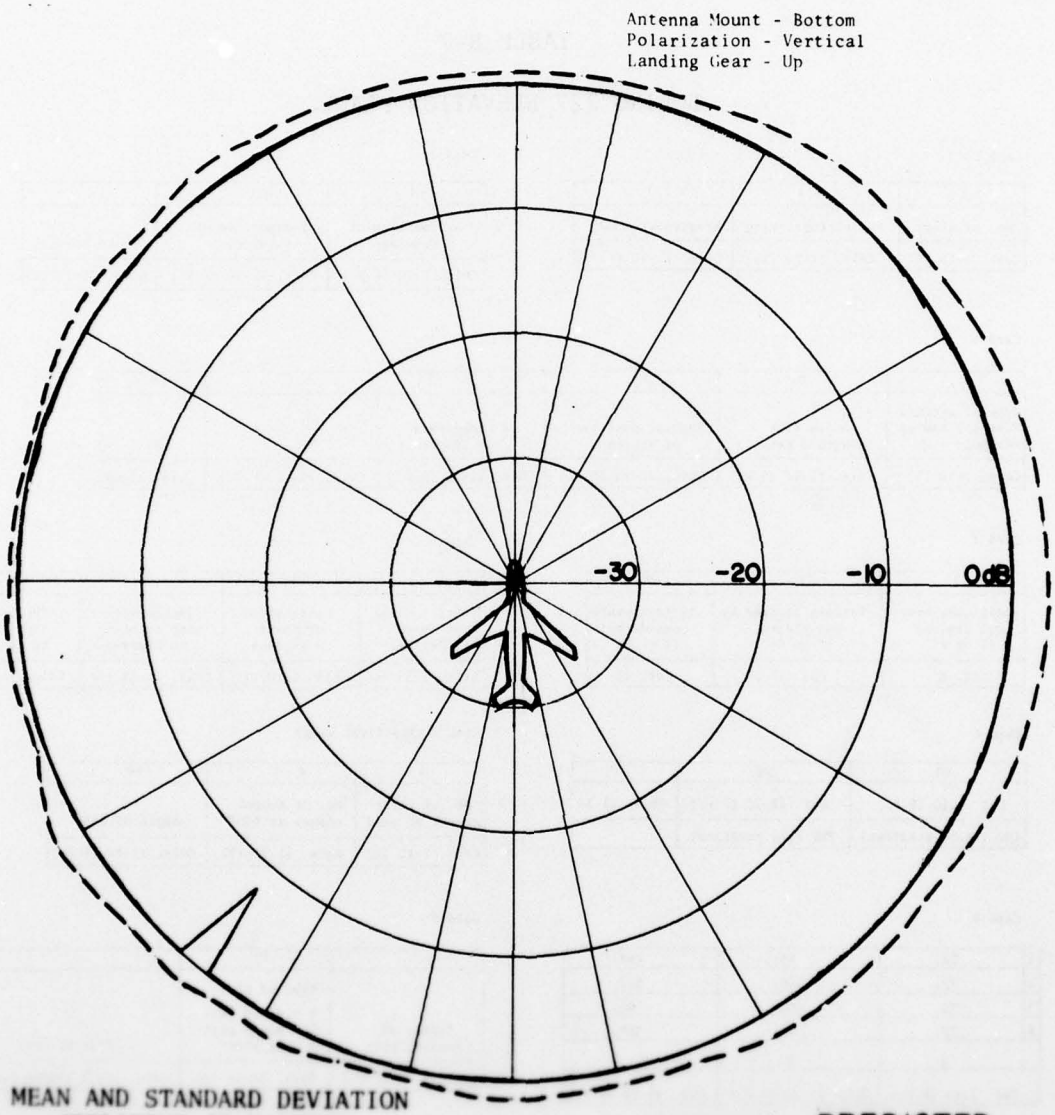

Figure B-8. Boeing 727 azimuth plane (E-THETA).

TABLE B-8

BOEING 727 AZIMUTH PLANE

Card 1

2	4	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

90.	84.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of Sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	0.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WM	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	T
Additional Write out desired (T or F)	Pattern plotted by pen plotter (T or F)	Is flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

90	90	90	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6-10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

90.	0.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	PHC (phi rotation)	

Card 7 (for first wing)

4	4	180.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

1	72.	84.	264.
2	72.	600.	672.
3	72.	600.	768.
4	72.	84.	588.
	X	Y	Z
	Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Col. 21-30 (F.P.)

Card 9

4.	3	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

For Additional Wings

Card 7

4	4	180.

Card 8

1	72.	84.	264.
2	72.	600.	672.
3	72.	600.	768.
4	72.	84.	588.

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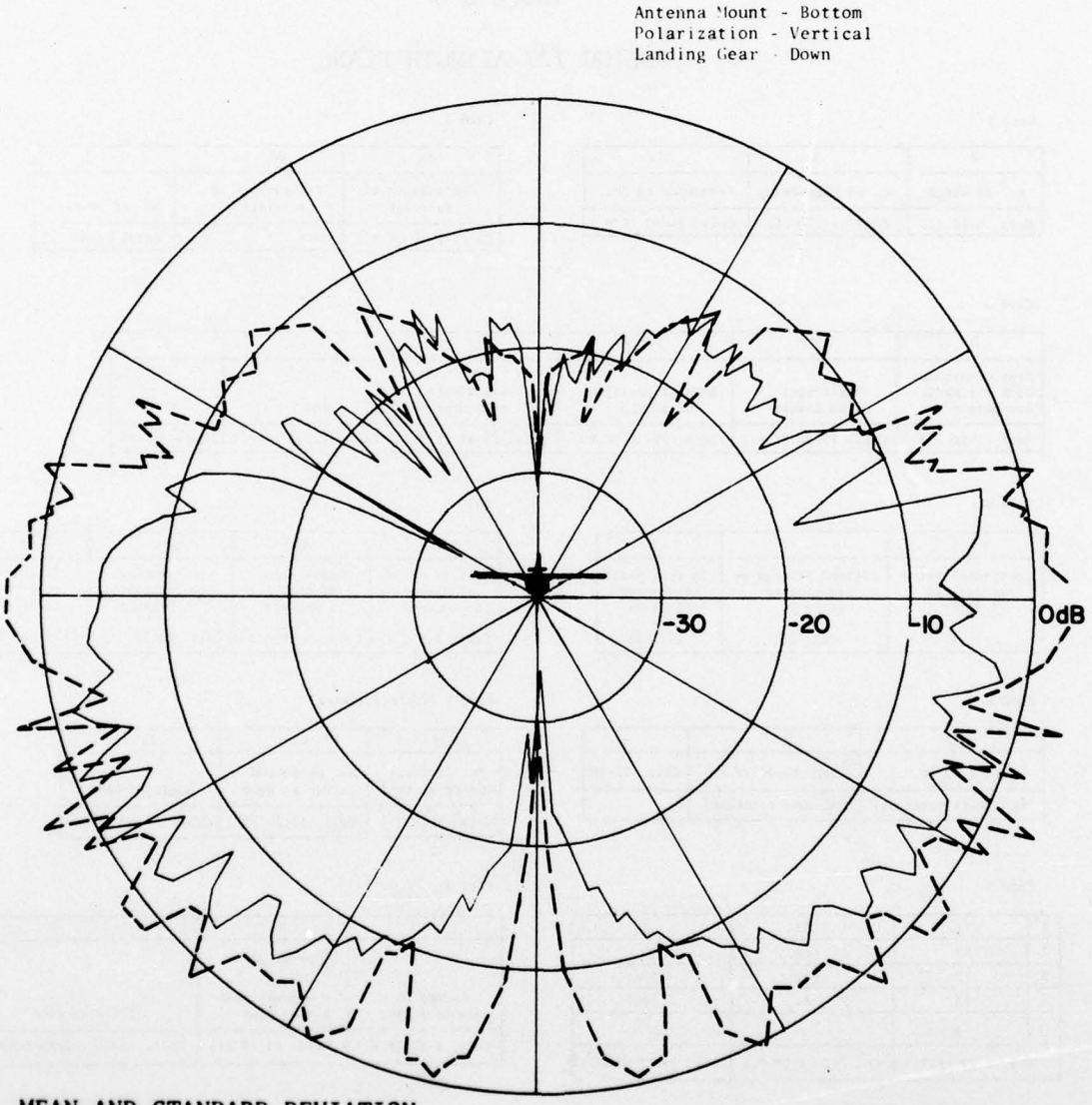

Figure B-9. Cessna 150 roll plane (E-PHI).

TABLE B-9

CESSNA 150 ROLL PLANE

Card 1

2	4	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

25.	20.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of Sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	0.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WN	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	T
Additional Write out desired (T or F)	Pattern plotted by pen plotter (T or F)	Is flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

90	90	90	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6-10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

0.	0.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	PHC (phi rotation)	

Card 7 (for first wing)

4	4	180.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

1	-24.	18.	-9.
2	-24.	192.	-6.
3	-24.	192.	36.
4	-24.	18.	54.
	X	Y	Z
	Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Col. 21-30 (F.P.)

Card 9

4.	3	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

For Additional Wings

Card 7			
	4	4	180.
Card 8			
1.	-24.	-18.	-9.
2.	-24.	-192.	-6.
3.	-24.	-192.	36.
4.	-24.	-18.	54.

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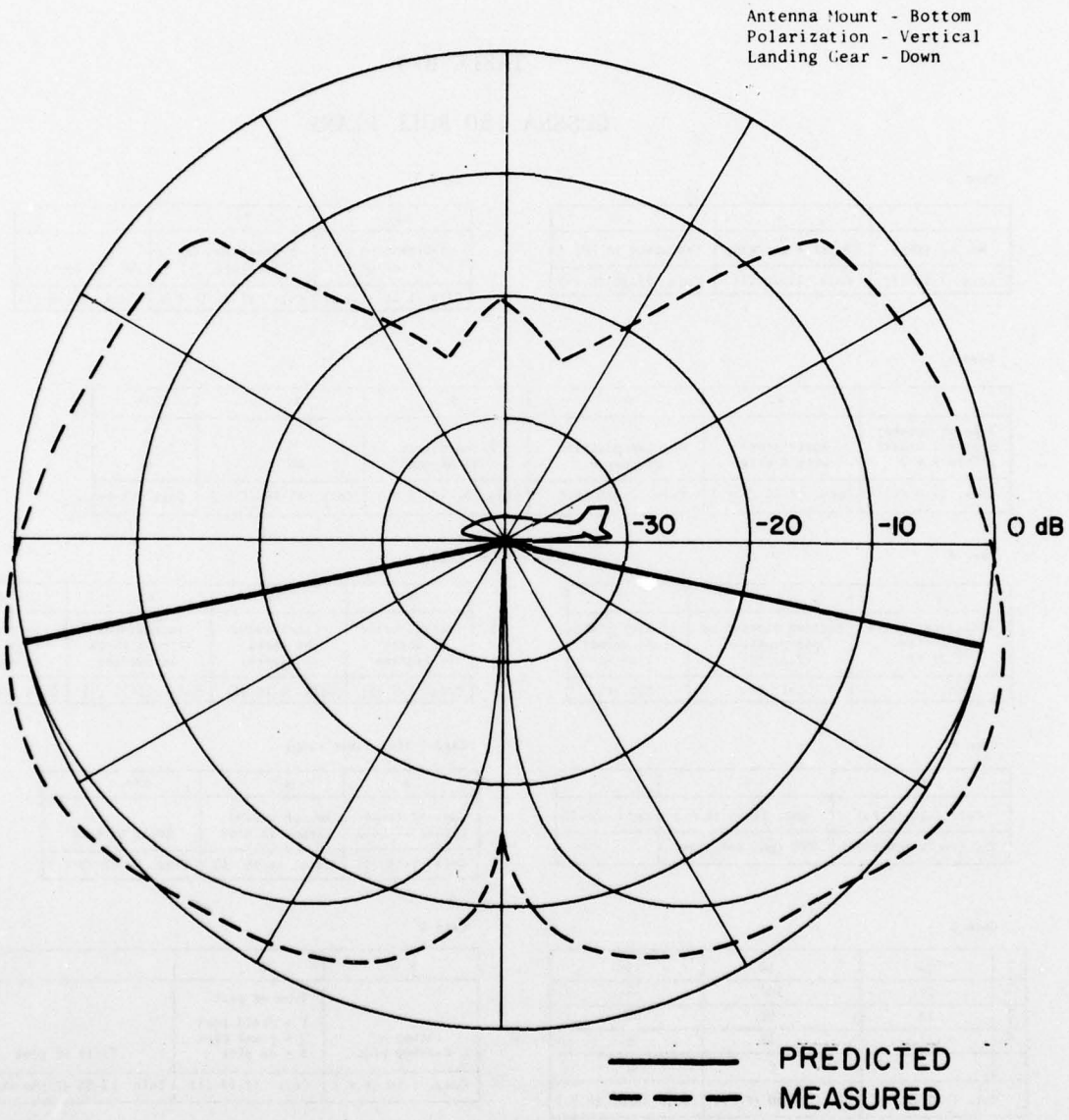

MEAN AND STANDARD DEVIATION
(RELATIVE dB VALUES)

μ = 4.2 dB
σ = 3.5 dB

Figure B-10. Cessna 150 elevation plane (E-PHI).

TABLE B-10

CESSNA 150 ELEVATION PLANE

Card 1

2	4	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

25.	20.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of Sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	0.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WN	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	T
Additional Write out desired (T or F)	Pattern plotted by pen plotter (T or F)	Is flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

89	89	89	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6-10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

90.	90.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	PHC (phi rotation)	

Card 7 (for first wing)

4	4	180.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

1	-24.	18.	-9.
2	-24.	192.	-6.
3	-24.	192.	36.
4	-24.	18.	54.
	X	Y	Z
Col. 1-10 (F.P.)		Col. 11-20 (F.P.)	Col. 21-30 (F.P.)

Card 9

4.	3	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

For Additional Wings

Card 7			
	4	4	180.
Card 8			
	1. -24.	-18.	-9.
	2. -24.	-192.	-6.
	3. -24.	-192.	36.
	4. -24.	-18.	54.

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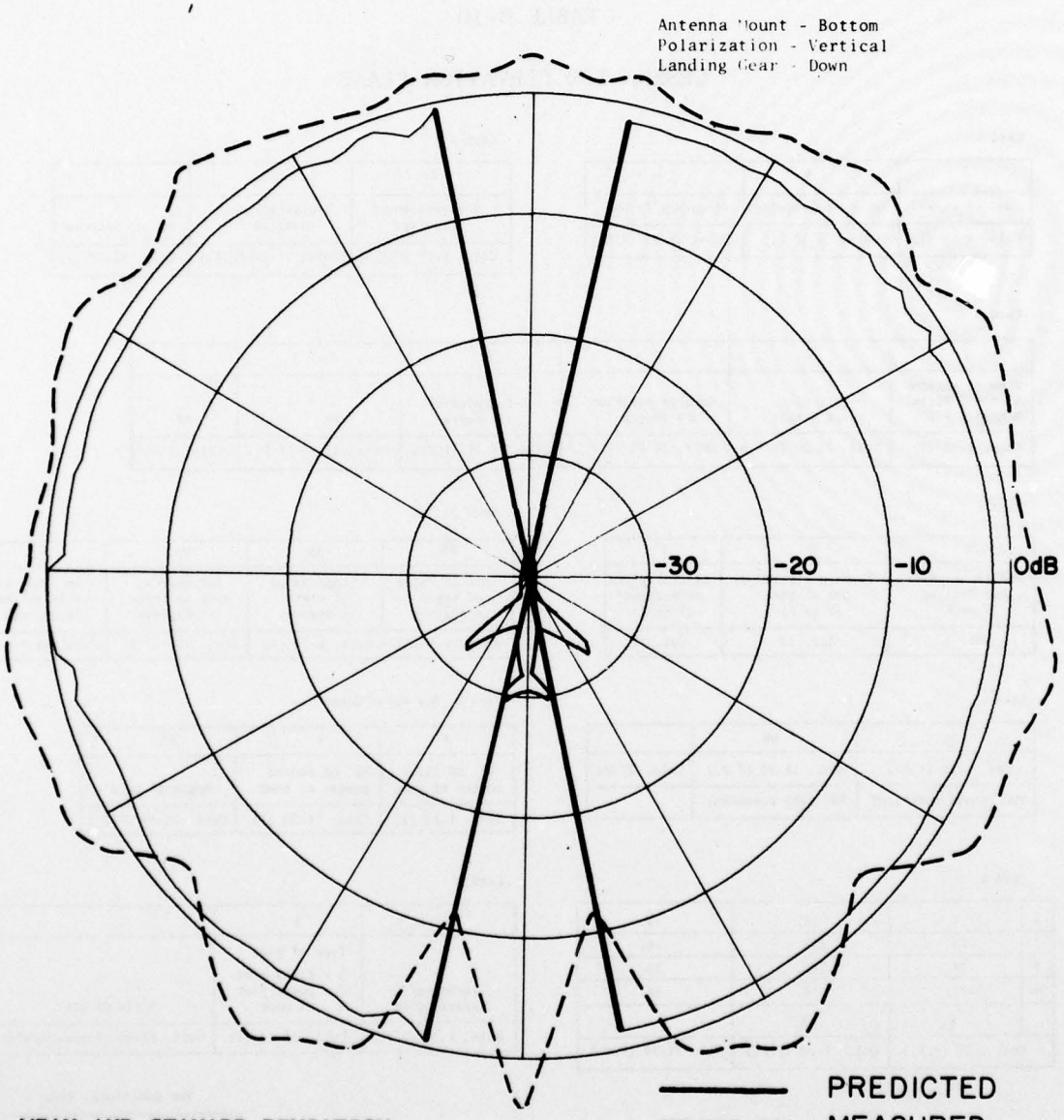

MEAN AND STANARD DEVIATION
(RELATIVE dB VALUES)

μ = 5.3 dB
σ = 2.3 dB

Figure B-11. Cessna 150 azimuth plane (E-THETA).

TABLE B-11

CESSNA 150 AZIMUTH PLANE

Card 1

2	4	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

25.	20.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of Sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	0.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WN	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	T
Additional Write out desired (T or F)	Pattern plotted by pen plotter (T or F)	Is flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

90	90	90	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6-10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

90.	0.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	PHC (phi rotation)	

Card 7 (for first wing)

4	4	180.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

1	-24.	18.	-9.
2	-24.	192.	-6.
3	-24.	192.	36.
4	-24.	18.	54.
	X	Y	Z
	Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Col. 21-30 (F.P.)

Card 9

4.	3	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

For Additional Wings

Card 7			
	4	4	180.
Card 8			
1.	-24.	-18.	-9.
2.	-24.	-192.	-6.
3.	-24.	-192.	36.
4.	-24.	-18.	54.

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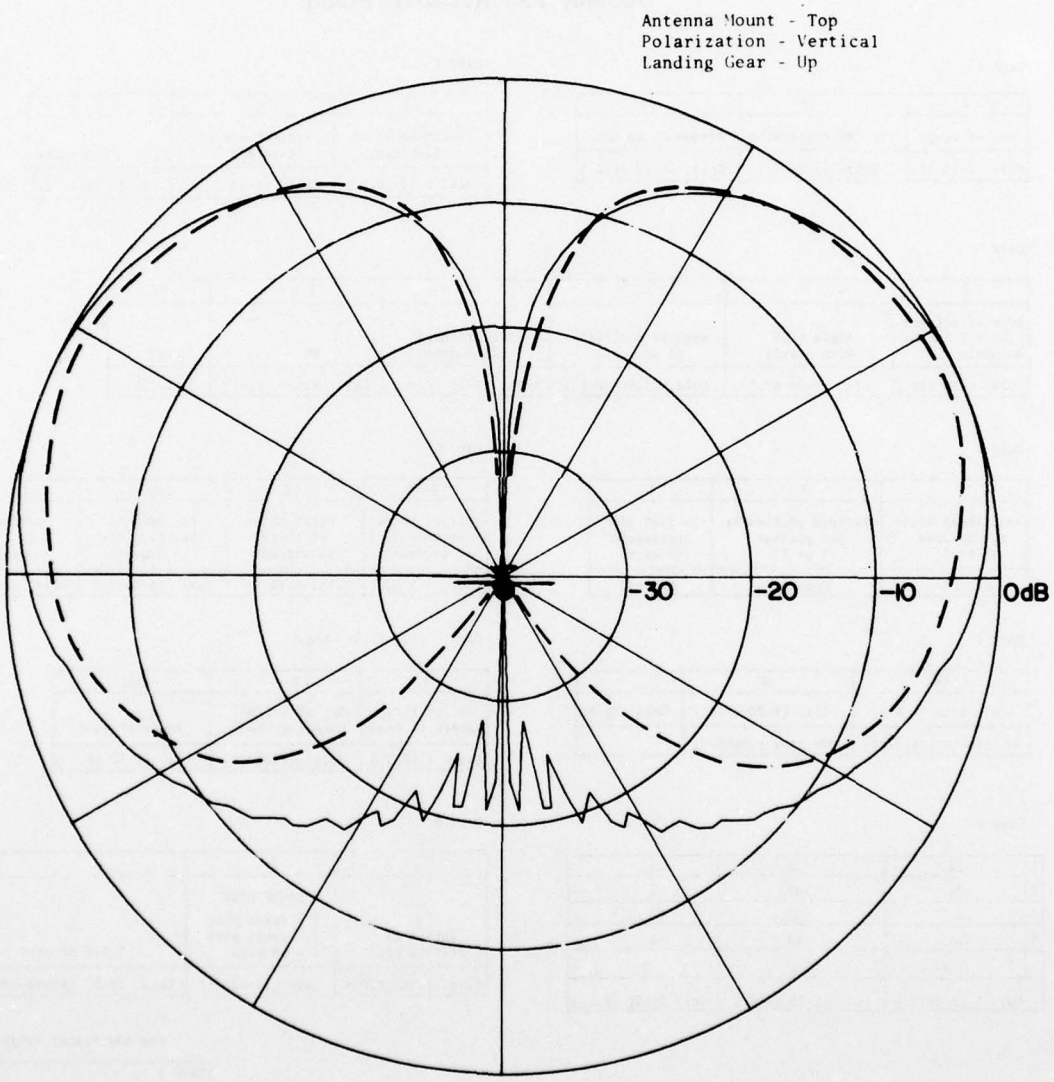

Figure B-12. F-4H roll plane (dB plot; E-PHI).

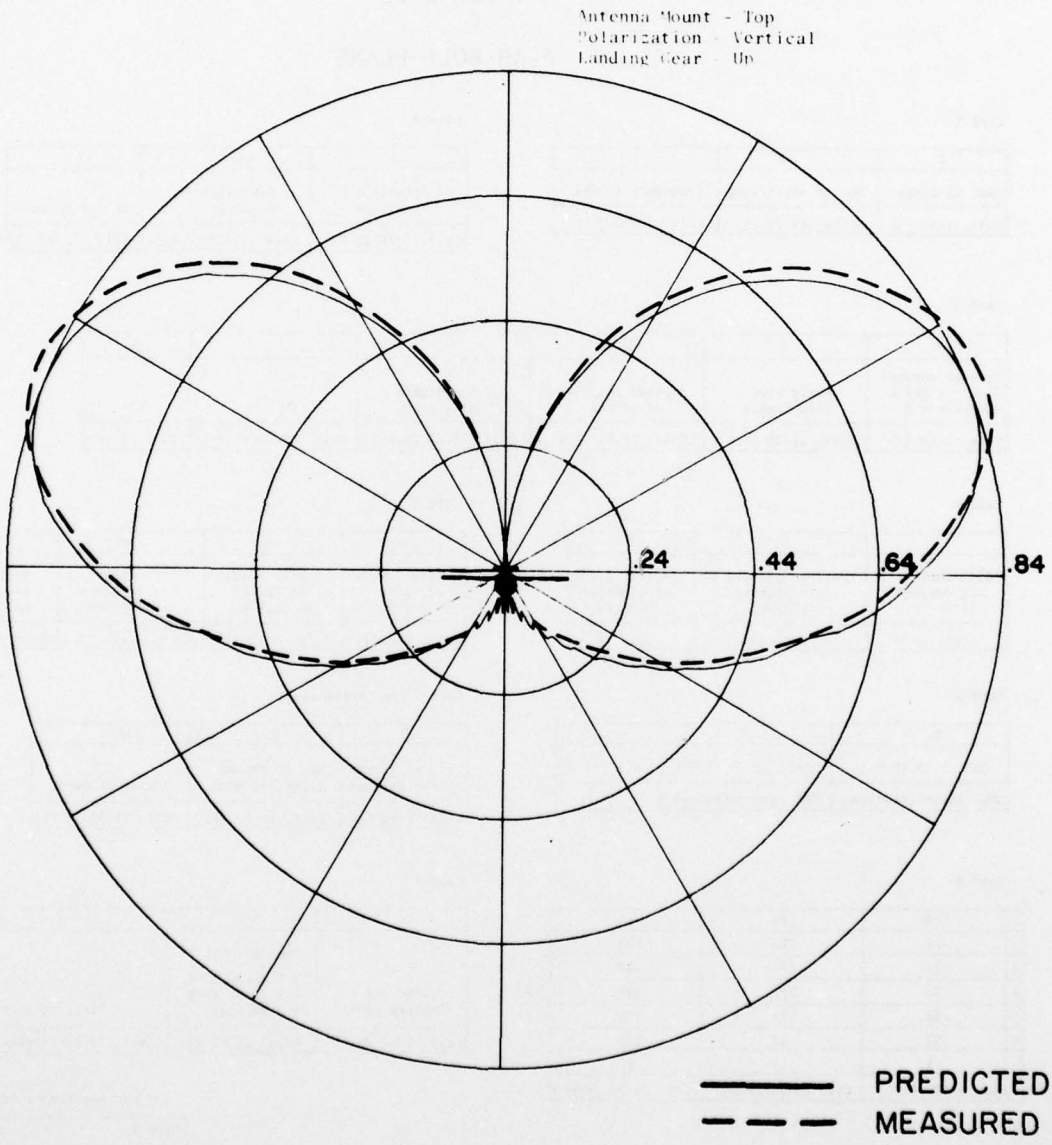

Figure B-13. F-4H roll plane (field plot; E-PHI).

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TABLE B-12

F-4H ROLL PLANE

Card 1

2	6	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

52.	44.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of Sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	0.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WM	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	F
Additional Write out desired (T or F)	Pattern plotted by pen plotter (T or F)	Is flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

90	90	90	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6-10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

0.	0.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	PHC (phi rotation)	

Card 7 (for first wing)

2	5	167.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

1	-32.	44.	-6.
2	-32.	153.	102.
3	-32.	237.	192.
4	-32.	237.	237.
5	-32.	153.	225.
6	-32.	44.	204.
	X	Y	Z
	Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Col. 21-30 (F.P.)

Card 9

4.	3/1	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

For Additional Wings

Card 7
2 5 167.
Card 8
1. -32. -44. -6.
2. -32. -153. 102.
3. -32. -237. 192.
4. -32. -237. 237.
5. -32. -153. 225.
6. -32. -44. 204.

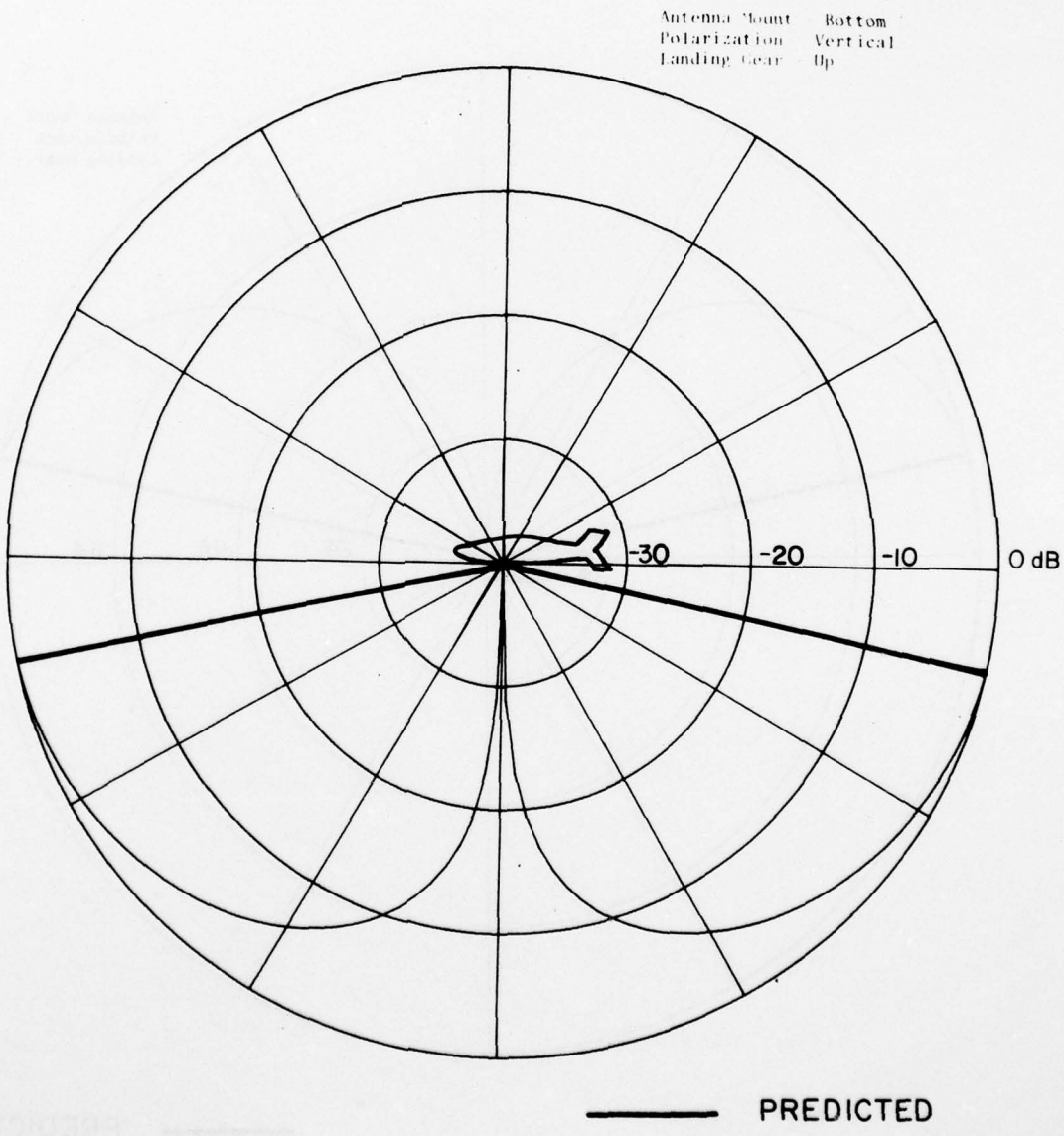

Figure B-14. F-4H elevation plane (dB plot; E-PHI). .

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EVALUATION OF A MODEL FOR SYNTHESIZING AIRCRAFT ANTENNA PATTERN--ETC(U)
FEB 76 A BULAWKA, S STOVER F19628-78-C-0006
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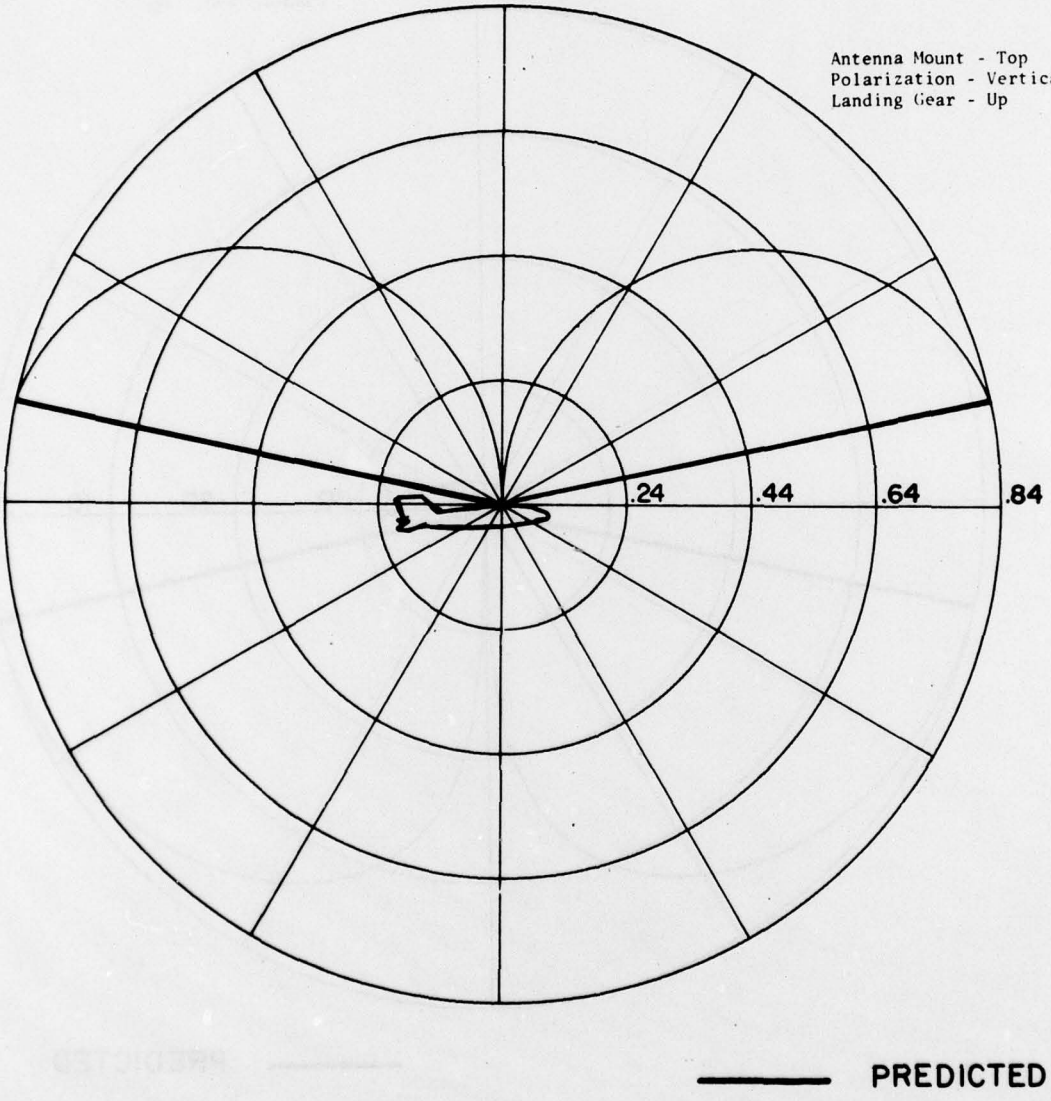

Figure B-15. F-4H elevation plane (field plot; E-PHI).

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TABLE B-13

F-4H ELEVATION PLANE

Card 1

2	6	1.
No. of wings	No. of edges/wing	Frequency in GHz
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 2

52.	44.	1
X-dimension of fuselage	Y-dimension of fuselage	No. of Sources
Cols. 1-10 (F.P.)	Cols. 11-20 (F.P.)	Cols. 21-30 (I)

Card 3

2	0.	0.	0.	1.	0.
Type of antenna Slot = 1 Radial monopole = 2	Angle slot with Z-axis	Angular position of source	Z-coordinate of source	WM	WP
Cols. 1-10 (I)	Cols. 11-20 (F.P.)	Cols. 21-30 (F.P.)	Cols. 31-40 (F.P.)	Cols. 41-50 (F.P.)	Cols. 51-60

Card 4

F	T	F
Additional Write out desired (T or F)	Pattern plotted by pen plotter (T or F)	Is flat plate considered? (T or F)
Col. 5	Col. 10	Col. 15

Card 5

89	89	89	2
Initial value of theta in degrees	Final value of theta in degrees	Incremental step in theta in degrees	Incremental step in phi in degrees
Cols. 1-5 (I)	Cols. 6-10 (I)	Cols. 11-15 (I)	Cols. 16-20 (I)

Card 6

90.	90.	
Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Cols. 21-30
THC (theta rotation)	PHC (phi rotation)	

Card 7 (for first wing)

2	5	167.
No. of first corner at bend	No. of second corner at bend	Angle of bend
Cols. 1-10 (I)	Cols. 11-20 (I)	Cols. 21-30 (F.P.)

Card 8

1	-32.	44.	-6.
2	-32.	153.	102.
3	-32.	237.	192.
4	-32.	237.	237.
5	-32.	153.	225.
6	-32.	44.	204.
	X	Y	Z
	Col. 1-10 (F.P.)	Col. 11-20 (F.P.)	Col. 21-30 (F.P.)

Card 9

4.	3/1	
Inches of desired plot	Type of plot 1 = field plot 2 = power plot 3 = dB plot	Title of plot
Cols. 1-10 (F.P.)	Cols. 11-12 (I)	Cols. 13-55 (Alpha-numeric)

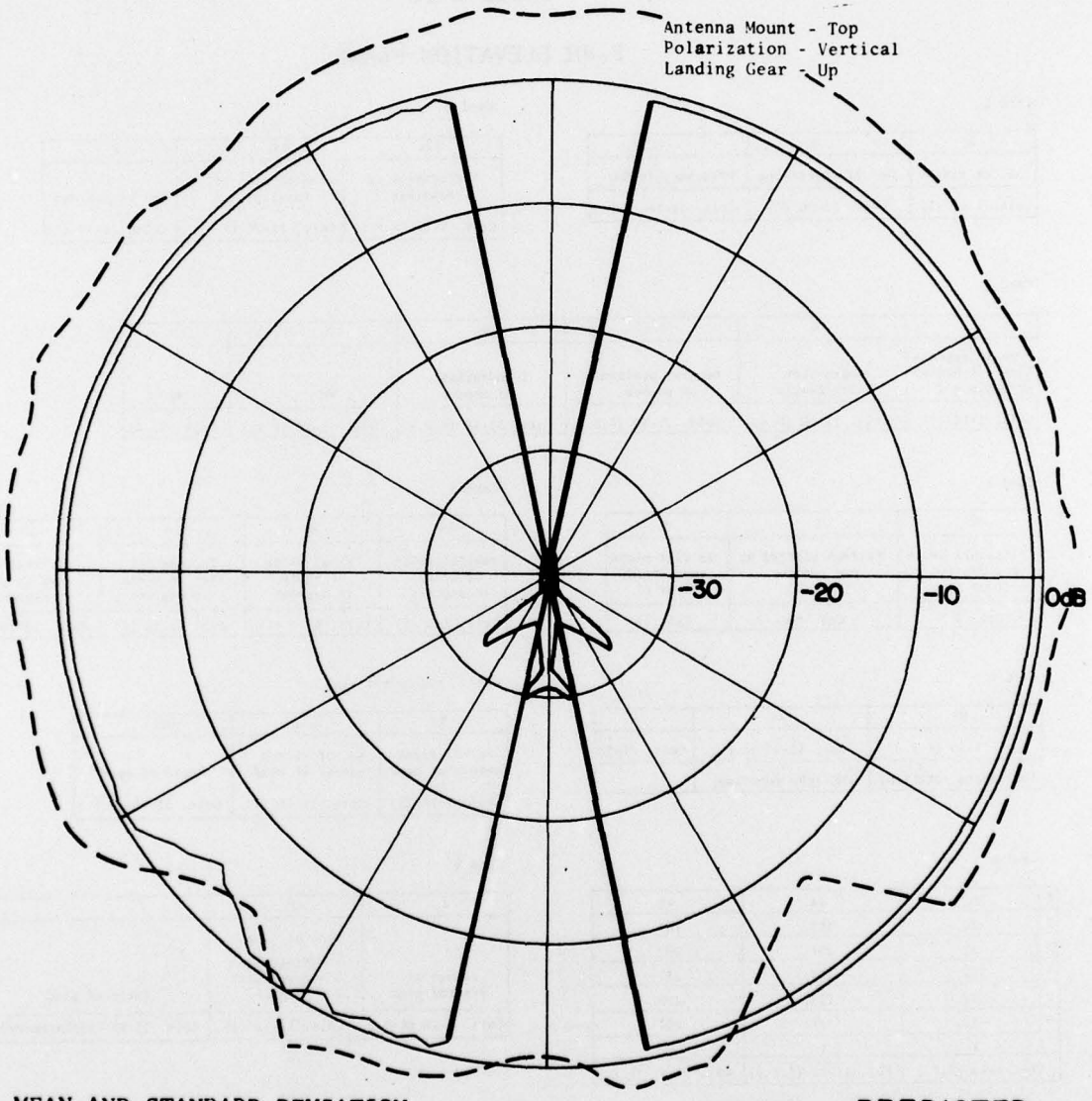
For Additional Wings

Card 7

2 5 167.

Card 8

1. -32. -44. -6.
2. -32. -153. 102.
3. -32. -237. 192.
4. -32. -237. 237.
5. -32. -153. 225.
6. -32. -44. 204.



MEAN AND STANDARD DEVIATION
(RELATIVE dB VALUES)

μ = 2.4 dB
σ = 1.4 dB

Figure B-16. F-4H azimuth plane (dB plot; E-THETA).

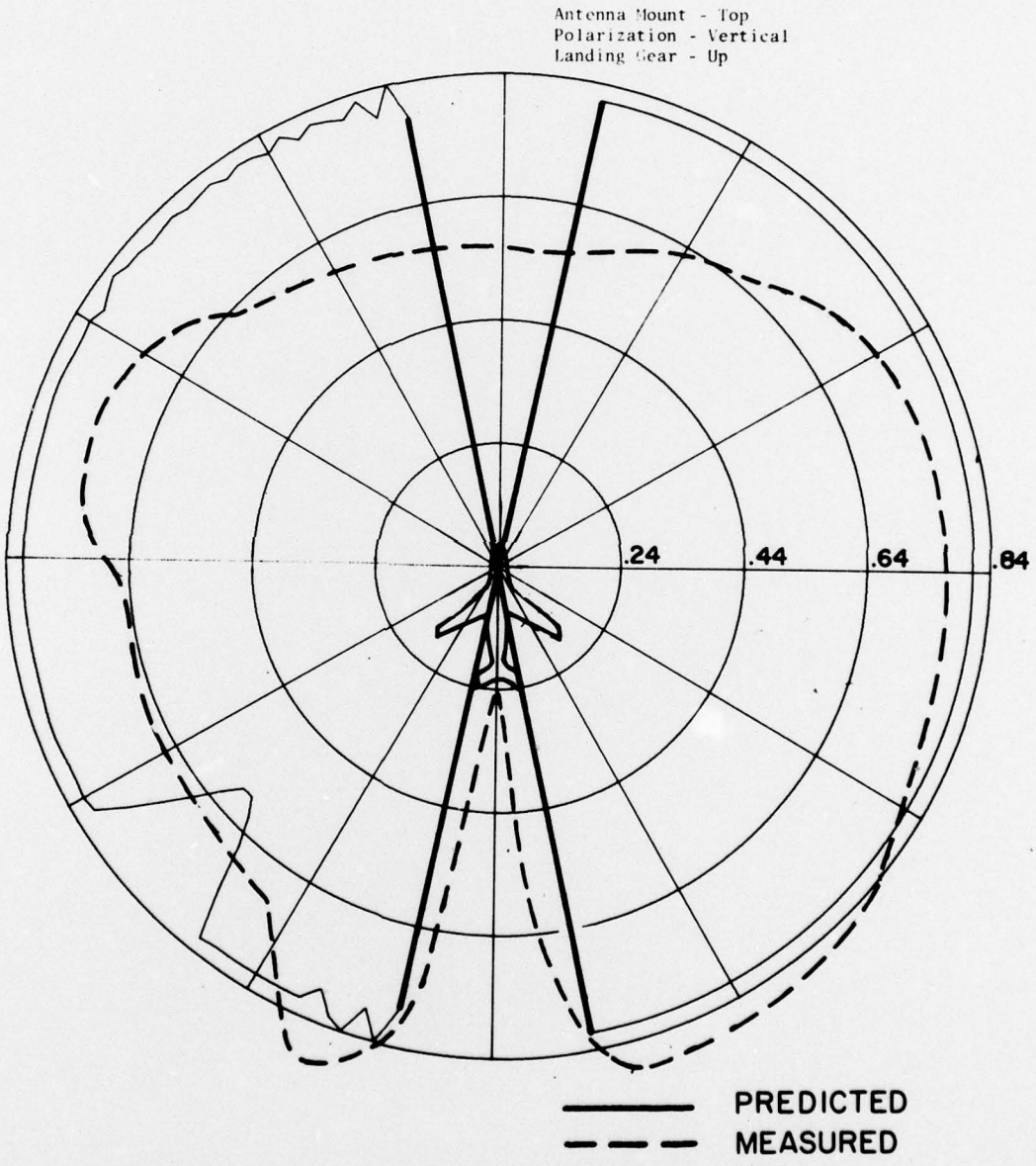


Figure B-17. F-4H azimuth plane (field plot; E-THETA).